J. Royse Wilding

THE

ROADS AND RAILROADS,

VEHICLES,

AND

MODES OF TRAVELLING,

OF

ANCIENT AND MODERN COUNTRIES;

WITH ACCOUNTS OF

BRIDGES, TUNNELS, AND CANALS,

IN

VARIOUS PARTS OF THE WORLD.

Let us visit all the countries of the earth, and wherever we find no facilities for travelling from a city to a town, or from a village to a hamlet, we may pronounce the people to be barbarians.——RAYNAL.

LONDON;
JOHN W. PARKER, WEST STRAND.

M.DCCC.XXXIX.

PREFACE.

The object of the present volume is to lay before the general reader some easy details on a subject of first-rate importance, whether considered in a national point of view, or with reference to the advance in civilization of the whole human family.

The reader may probably imagine that roads and rail-roads, bridges, tunnels, and canals, and the various contrivances adequate to the wants and demands of internal communication, scarcely admit of being treated in that easy, amusing, and instructive manner which less homely subjects might admit of; but when he considers that the progressive improvement of mankind is due as much to a diligent cultivation of love, peace, and good-will, as to the diffusion of the arts and elegancies of life; and when, at the same time, he reflects that this can only be brought about by a constant, easy, and safe means of communication between distant places, he surely cannot deem it unentertaining or uninstructive to trace the paths over which civilization has advanced, and is still advancing. It has, therefore, been one of our objects in the following pages to show that the improvement of mankind, and the perfection of the means of internal communication, have progressed simultaneously.

We have bestowed hasty glances on the people of many lands—we have seen the ancient Briton moving over his narrow trackway—we have traced the locomotive engine proceeding with astonishing speed over a smooth and elaborately-constructed line of road—and, in filling up the long interval between the states of society coeval with these two forms of locomotion, we have endeavoured to inculcate the useful lesson, THAT IN VIRTUOUS INDUSTRY AND ENTERPRISE, NATIONS, AS WELL AS INDIVIDUALS, FIND THEIR HAPPINESS AND WELL-BEING.

CONTENTS.

Chapter XVI.

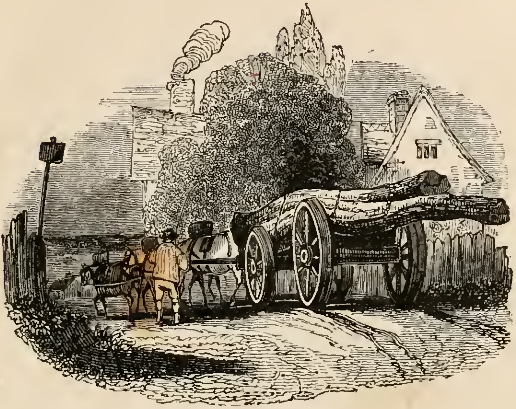
Chapter XVII.

Chapter XVIII.

ERRATA.

P. 18, line 19, *for* give, *read* gives.
48, „ 17, *for* lc, *read* l.
65, „ 1, *after* remark, *insert* that.
71, „ 2, *for* now here, *read* no where.
98, „ 11, *for* tightness, *read* lightness.
101, „ 9, *for* Bicançon, *read* Besançon.
P. 152, line 13, *for* are, *read* is.
175, „ 9, *for* sea, *read* side.
197, „ 1, *for* are, *read* is.
197, „ 36, *for* is, *read* are.
324, „ 24, *for* pass, *read* passes.

ROADS AND RAILROADS.



CHAPTER I.

Of the Nature and Importance of Roads in general.

WHAT admirable things are roads! Admirable for their beauty, admirable for their utility; admirable, often, for the grandeur, either of their extent, or of their conception; admirable for their testimony to the civilization of the countries through which they pass, and for their influences upon the advance of that civilization. Admirable, too, for the industry, and often for the skill, displayed in their execution;—for the performance finished, and for the difficulties overcome!

Those, who, like ourselves, have had the happiness to be born and bred in the bosom of countries teeming with wealth, with arts, and with civilization, are in great danger of never being called upon to think how much they owe to those countries, (that is, to the past and present generations of their inhabitants,) for a thousand local advantages and aids, as well to their bodies as to their minds. How much, too, amid every blessing of the natural world, are they still indebted for to human genius, human ingenuity, and, more than all, to human industry and labour! How much, also, do they owe to the industry which has accumulated wealth, and to the genius, the judgment, the taste, the wisdom, the liberal outlay, the bold adventure, and the pious or the charitable purpose,—of their predecessors, or of their contemporaries!

It has been well observed that roads, canals, and navigable rivers, may justly be considered as the veins and arteries through which all improvements flow. To internal commerce and agriculture, they are as the veins and arteries to the human body. Through these the blood circulates in every direction, preserving life, health, and vigour to the animal system; but, if this circulation be by any means checked or obstructed, even in the remotest part, that part soon becomes useless, and sinks into decay, and this evil is in some degree felt throughout the whole body. So it is with respect to the commercial and agricultural systems. Without a free and uninterrupted intercourse, it is impossible they can exist, or, at least, produce to the community at large so many important benefits as they otherwise might do. How many, for example, are the places in almost every country, that might be rendered doubly valuable, if possessed of good roads! What immense quantities of the finest timber are now growing in forests inaccessible for want of roads! What valuable strata of metals and coals now lie in undisturbed repose in inaccessible districts, and what vast quantities of valuable land are now lying waste for want of means of communication with them! Indeed, the riches and strength of a country so much depend upon an easy and uninterrupted communication by good roads, that we generally find the state of the public thoroughfares to be a pretty sure test of the state of the country itself. "Let us travel," says Raynal, "over all the countries of the earth, and wherever we find no facilities for travelling from a city to a town, or from a village to a hamlet, we may pronounce the people to be barbarians." A modern writer also observes that the making of roads is fundamentally essential to bringing about the first change that every rude country must undergo, in emerging from a condition of poverty and barbarism.

It is difficult for us to conceive the state of a country, which is destitute of the conveniences of roads: yet there was a time in England, when, from the absence of highways, the north of our island was to the south as a foreign land, requiring, not merely days, but weeks, for the passage of a single conveyance; when, in many parts, wheel-carriages could not travel at all; when passengers, and goods, and even coal, manure, and grain, were carried on horses' backs; and a wagon, with a single load, travelling only a few miles a day, required eight or ten horses to draw it over the soft and unequal ground which served the purpose of a road or track-way. Even at the present time, in some parts of the world, portions of crops are left to rot upon the ground, because there are no roads whereby to remove them; and in Spain, sheep are, (or recently were,) killed for the fleece only, and the carcass abandoned, because the expense of removing it to any distance would be more than its worth; so miserable there are the ways which are dignified by the name of *roads*.

The value of roads is thus happily expressed by Dr. Anderson. "Around every market-place you may suppose a number of concentric circles to be drawn, within each of which certain articles become marketable, which were not so before, and thus become the sources of wealth and prosperity to many individuals. Diminish the expense of carriage but one farthing, and you widen the circles, you form as it were a new creation, not only of stones and earth, and trees and plants, but of men also, and what is more, of industry and happiness."

The roads chiefly to be spoken of in these pages are great or considerable roads; roads of vast length, and of ample breadth; roads of ingenious and toilsome construction; roads of which the courses affect the interests, the prosperity, and even the virtues of communities; and, sometimes, not of communities alone, but of regions, and all the quarters of the globe.

The purposes of roads are commercial, military, neighbourly. They concern the traffic of towns, of nations, and of the world; they concern the inward peace and outward safety of states; they concern the intercourse of kindred and friends, and of mankind. The tendency of their extension and perfection is to make friends of all the species; to communicate from man to man all human benefits; to diffuse arts, sciences, and learning; to spread from district to district, and from land to land, all human discoveries and improvements; to obliterate prejudices; to extinguish enmities; to promote and recompense industry; to banish poverty; to make, of provinces, and kingdoms, and even of the entire globe, so many thriving and harmonious cantons.

These are some of the public claims of roads; but how many are not their private benefactions? It has been said of painting, that it gives us, to enliven, and even to perpetuate our affections, the faces of our parents, of our children, and of our friends; and of writing, that it enables each of these, at whatever distance, to interchange their thoughts: but how well do roads also contribute to all these tender, all these moral aims;—roads, which either facilitate, or at least enable parents, and children, and friends, personally to meet each other; or, stopping short of that chiefest good, facilitate, or permit, the travel of mail-carriages and postmen, and the interchange of letters!

How much happiness, how much virtue, to say nothing of how much knowledge, and how much wealth, through every thread of private life, depend upon these meetings, and upon these distant communications and memorials; and how much do these meetings, these communications, and this imparting and possession of memorials, depend upon the multiplication, the extension, and the perfection of roads!

Paintings are good things, but meetings are still better; and roads minister to all conveyance, whether of ourselves, or of our letters, or of our pictures. It is a pretty thought, nevertheless, which has been put into the mouth of a little boy, when writing to his mother, that he would not have contented himself with writing to her, if he could have come to her;—if Love, which had lent him one quill of his wing, with which to write, had, kinder still, lent him his whole wing, and both his wings, to fly into her arms.

And, then, for public news; for matters which regard business, pleasure, or information. How small, either is or can ever be, the interchange of intelligence where roads are wholly wanting, or at best but insufficient, for the bringing of it to our doors! Be it the minstrel, the travelling merchant, the pilgrim, or the friend; or, simply the newsman or the postman (where these offices are separate), whom roads enable to reach our dwelling, how much do we not owe to those *roads*, the mediums of the welcome visits! Well does the poet describe the service of the country-postman!

> Hark! 'tis the twanging horn! o'er yonder bridge,
> That with its wearisome but needful length,
> Bestrides the wintry flood, in which the moon
> Sees her unwrinkled face reflected bright,
> He comes, the herald of a noisy world,
> With spattered boots, strapped waist, and frozen locks;
> News from all nations lumbering at his back.
> *   *   *   *   *   *   *
> But oh, the important budget, ushered in
> With such heart-stirring music! who can say
> What are its tidings?

But, besides post-*men*, we are not yet wholly without post-*women*, and news-*women*. Those *couriers* of the remoter villages, who, though not quite so industrious, are, as might well be hoped, more expeditious than the same class of functionaries in the south of Italy; though, as roads are improved and multiplied, and as traffic and wealth increase with us, their number is doubtless decreasing.

In the South of Italy, from the absence of cross-country posts, and of other means of communication, women are very generally employed to carry letters, small parcels, and similar little burdens, from one place to another, like our post-women. These female couriers (*corrieri*, as it sounds grandly to hear them called, though the name implies nothing but *runners*), always perform these journeys on foot, and often with *bare feet*, and in spite of the incumbrance of their bags and parcels, they almost uniformly carry with them their distaffs, and spin as they go,—yet walking, upon an average, at the speed of three miles in an hour. A modern traveller gives us reason to believe, that this practice of spinning as they walk, either on the roads or in the fields, is general from Italy into Greece, and thence to Asia Minor. At the foot of Mount Parnassus, to this day, when the women and girls in the evening, as the shadow of the mountain lies outstretched upon the plain below, are seen driving the cows to their steadings for the night;—or when on a journey from one town or village to another;—or when (which is less remarkable) they are keeping their flocks upon the hills,—the primitive distaff is still in their hands, and they move about, still spinning their cotton or their linen thread.

Here, too, we have left aside all mention of the benefits conferred upon us by roads, where travel or change of place in our own persons has for its object only health, or pleasure, or instruction; and yet, are these but trifles? Travel for instruction is happily combined with the promotion of health and pleasure; and it advances always, at the same time, in lower or in higher degree, all those benefits of communication of man with man, in arts, in sciences, in learning, in peace, in safety, in personal prosperity, and in reciprocal good feeling, which I have described as the general tendency of the existence and formation of roads. Man separated from man, and family from family; neighbourhood cut off from neighbourhood; town separated from country; kingdom from kingdom; and region from region;—all are comparatively poor, ignorant, vicious, and unhappy. But, joined in easy and in frequent intercourse, the possessions, the knowledge, and the hearts of all are enlarged; and each becomes the happier, while seeking and promoting the happiness of others!

"Happy," says a writer somewhat eloquent, but also somewhat superficial, "happy the man to whom the horizon of his birth-place is the limit of the earth, and the next village a foreign country!" Doubtless it may occur, that much virtue and happiness, much peace and comfort, fills the lot of particular individuals so circumstanced; but the general rule will be far otherwise. For the most part, persons thus cut off from the world, and from their fellow-creatures, will pass lives of comparative indolence, and consequently, of comparative suffering. Such will be uninformed, and therefore narrow-minded; strange to all men, and counting all men strangers, and therefore enemies to all, and dreading all as enemies; and denied, at the very least, that happiness which is derived from making others happy, and which seems like one of the wants of human nature.

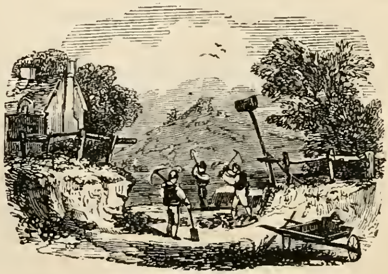
If the writer quoted above were right, in what he advances, roads would be among the inflictions of our lives; but the reverse is so much the truth, that (especially in anticipation of a little further inquiry into the value of roads,) we may rather avail ourselves of another thought of the same pen, and apply it safely to the eulogy of road-makers and road-menders.

"He," says the same cynical philosopher, "that causes two ears of wheat, or two blades of grass, to grow, where only one of either grew before, is a greater benefactor to mankind than any other that can be named; and thus the spades of slaves have done more good than all the swords of conquerors." Now, without disputing what we owe to the husbandman, or stopping to inquire what may or may not have been achieved by the swords of conquerors, it is certain that the pickaxe and spade of the road-maker and road-mender, and even the hammer of the stone-breaker, as aiding in those tasks, have done, and are daily doing, immeasurable services to mankind; and not the least of them, services to the growers and gatherers, as well as to the consumers, of wheat and grass!

Roads are benefits, of which, directly, or indirectly, all the world partakes; the native and the foreigner, the country and the town, the palace and the cottage, the farm-yard and the warehouse. Abundance of truths, to be displayed in the succeeding chapters, will contribute, therefore, to an acknowledgment of the value of the road-maker. The philosopher, it has been said, follows the sword; and it is the same as to the merchant and the artisan. But how slowly and uncertainly the whole, without the help of roads! Honour to the road-maker!

It is, then, this view, among numerous others,—moral and intellectual,—that, while we shall relate the histories, and describe the structure, appearances, and uses of so many vast, magnificent, and beneficial contrivances and works of art, connected immediately with the purposes of travel and conveyance, and mediately with so great a multitude of the very highest human interests;—it is this view that we are anxious should by no means escape attention; for, by exciting an interest upon that point, this book will have a value yet wider and more high than it can otherwise attain to.

While relating the story of human labour, while recording the triumphs of human genius, while describing the origin, the operation, and the products of even the most ordinary accommodations of human life; while talking of works, machines, and inventions, which relate to the immediate purpose of this book, we shall be carried to the recollection of that immense debt of gratitude and respect, which is due from us to such portions of mankind as, by any means whatever (by wealth and enterprise; by genius, by patience, by zeal, or by toilsome labour and sweat of the brow), have severally contributed to our possession of so many monuments of use and beauty, in our own country, and in other parts of the world. Honour to the road-maker!



Rope-Bridge in the Himalaya Mountains.

CHAPTER II.

Mixed Facilities and Difficulties of all the Natural Mediums of Travel and Conveyance; either Air, Water, Earth, or Land.—Contrast of a Rail-road with a Rope-bridge.—Obstacles to Land-travel.—Mountain-passes.—Travelling in the Desert.

The moving creatures of the globe enjoy, distributively, for the respective theatres of their movements, the air, the water, and the land. Birds fly in the air; fishes swim in the waters; and beasts walk, and run, and leap upon the earth. Insects and reptiles, in the variety of their kinds, and in the changes of form which attend the lives of many of their species, may be spoken of as dispersed and mixed in and throughout the whole of the three regions: as flying in the air, swimming and creeping in the waters; and creeping, walking, running, leaping, and even burrowing, in and upon the earth. Among the several features, by the partial exhibition of which all created things whatever are seen somewhere to approach and meet each other, exceptions and qualifications, in addition even to these, may be demanded. There are birds which scarcely fly, or make their movements in the air; there are fishes that scarcely swim, or make their movements in the water;

and there are beasts which scarcely walk, or run, or leap upon the earth, or which absolutely do neither.

Again: there are birds which not only swim upon the water, but swim and pursue their prey under its surface, and which, while themselves fishing, are sometimes caught, at considerable depths, in fishermen's nets. There are other birds which descend into the waters to walk along their bottoms; as also those which, as I have already intimated, instead of flying in the air, live upon the earth, walking, running, and leaping upon it, like the beasts, its proper denizens. Add to this, that there are fishes which *fly*, or at least leap or dart into the air; and beasts also, that is *mammalia*, (as bats and flying squirrels,) which, more or less, like birds, make their movements in the air; and others, (as seals and otters, and beavers and musk-rats,) which, more or less, like fishes, make their movements, and seek their sustenance, in the bosoms, or on the beds, of the seas, or of the rivers. Still, the special destination of the three superior classes of moving creatures, to the three regions of air, and water, and earth respectively, remains uncontradicted.

A medium, or a surface, in or upon which to move, was a needful provision, in the way of outward counterparts to the inward powers of locomotion. The creatures upon which they have been bestowed, possessing from within the power of locomotion, it was required that they should find facilities without, either in the medium or element to be moved through, or in the surface to be moved upon.

The *air* and the *water* present, respectively, mediums or elements in or upon which birds and fishes are severally able to exert their inward or inherent locomotive powers; and the *earth* presents to men, and to the four-footed creation, a surface similarly adapted to their peculiar wants, or similarly fitted to their peculiar structure.

But neither the earth, the air, nor the water, present facilities for locomotion, unattended by those occasional difficulties which occur in every other department of creation. The yielding element of water, which has been described as so unresisting to the bodies and the motions of the finny tribes, has assuredly its local and occasional contrarieties; its swells, its whirlpools, its tumultuous heavings, and its opposing currents, which obstruct and counteract the motive efforts of the fishes beneath its surface, as well as those of our ships and boats upon its surface; in one case, impeding their progress; in another, driving them in unwished-for directions; and, not unfrequently, casting them upon rocks and sands, exhausted, wounded, helpless, dead, or dying.

When the *waters*, at or near their surfaces, are ruffled by the winds, the fishes swim at greater depths than those which, species by species, they usually frequent; endeavouring thereby to avoid the danger attendant upon the commotion. But the refuge does not always avail them. Great storms upon the leeward coasts of continents and islands rarely, if ever, happen without causing the seas, and even the rivers, to cast upon the land large shoals of the smaller fishes, and to leave them there to perish; while, though in less numbers, the larger species similarly suffer.

The *air*, though another yielding and commodious element for giving passage to moving bodies, if not by variation of places, is, at least by variation of seasons or times, as partially uncertain as the water, and perhaps more so. We are better acquainted, indeed, with the vicissitudes of the atmosphere above us, than with those of the depths of the seas, and of waters that are beneath us; and can add our testimony, upon this latter subject, to the testimony of the birds which wing their flight in it! If we do not, like birds, (and in spite of our balloons,) very often ascend into its higher regions, we know what it is to stem its opposing currents, as they sweep over both the water and the earth, as they drive the waters at the same time with our ships; as we resist with difficulty, even if always with success, the blast that would lift us from our feet, which shakes the temple and the tower, bends to the earth the lofty trees of the forest, and threatens to bring all upon our heads! The birds, to which the air is the natural element of locomotion, often troubled, often discomfited, not unfrequently destroyed, by the contrarieties of the air, have ample experience of the partial difficulties of this second medium of transport. It would be easy to adduce examples.

The difficulties of *land*-travel, so often interposed by the simply natural circumstances of the earth, are largely experienced by all creatures that move by the aid of feet, and, therefore, among the rest, by all the human race; and by all creatures, too, they are often removed or mitigated through the help of art; and by man, as may well be expected, with more extensive art than by any others. The atmosphere, the seasons, the hours of the day and night, are sometimes hostile, for shorter or longer periods; but, besides these, there are difficulties of the surface only, which last the entire year. These are interruptions by seas and lakes, by rivers and torrents, by hills and mountains, by forests and morasses, by the rocks, and by drifting sands, all of which have exercised human skill and industry, to lighten or remove, and all with more or less success. Seas and lakes have been crossed in boats and ships; rivers and torrents have been crossed on bridges, or passed beneath their beds; hills and mountains have been levelled, or roads carried over their rugged faces, or pierced through their centres: trees have been felled, entangling underwood has been cleared away, morasses have been drained, or else intersected with long and lofty causeways; roads have been cleft through rocks, whose stony fragments have been made to harden and perpetuate the passages which by nature they had appeared to interdict: and if the drifting sands, in themselves, defy all efforts of improvement, upon a great scale, they yet admit of diminishing their obstacles, through the aid of beasts of burden, and by the choice of hours and seasons. Finally, all distance, and intemperance of climate, of season, and of weather, have been provided for by the invention or structure of countless sorts of land-carriages, and by the subjugation of so many of the animal species to the tasks of draught and carriage. This last resource might seem to belong to man alone, were it not that in the instance of that interesting little animal, the marmot, we are assured, that among its hay-making parties, one or more of the troop, laying himself upon his back, submits to be the *hay-cart*, while the others, that so pull him, submit to be the *hay-team* to carry home the stores for their long winter's sleep.

What a contrast between a scene upon the Liverpool and Manchester Rail-road, and the rope-bridge over a torrent in the Indian mountains, placed at the head of this chapter! In the former, enterprise and toil have united to cut a level passage through the hearts of rocks. It is here, perhaps, that we have an example—what with the rocks through which the passage is cut—the level to which the passage is reduced—the invention and workmanship of the iron *rails* which are laid upon it—the adaptation of carriages to move upon those rails,—the movement of those carriages by the power of steam-engines, themselves in locomotion; and finally, the ease and swiftness of travel attained through so much combined intelligence and industry, so far surpassing every thing within the power of foot of man or beast; it is here, perhaps, that we see what may be cited as the perfection of the artificial means of land-travel, and of the triumphs of civilized humanity over the impediments of nature!

Upon the other hand, the view of the rope-bridge over a torrent, presents, as a suitable contrast, the first dawnings of human art, in the conquest of the traveller's difficulties; dawnings which, however imperfect, are, in themselves, invaluable; for, as to the crossing of torrents and rivers where bridges of no kind are to be found, such impediments to human attempts will hereafter engage our attention!

But rivers, under many views, and canals in all, are helps to what still may be called *land*-travel. If rivers obstruct by their width, when we would cross them, they carry us forward, by their length, when we would either ascend or descend their streams. Rivers and canals and lakes, are the means of inland navigation,—the *watery ways* or *roads*,—of the countries in which they are found; in the same manner that the great ocean is *the great highway of nations*. "Canals," it has been observed, "are properly *roads*, to all intents and purposes."

The importance of roads, like that of other helps to land-travel of which we are about to speak, depends upon the number and magnitude of the natural obstacles which may happen to beset the traveller, and either wholly stop him, or add to his fatigues, his dangers, or delays. It must be earnestly impressed upon the minds of our readers, how greatly we are indebted to art, and to our fellow-creatures, for the ease, and even for the possibility of our ordinary means of travelling. We are, therefore, about to point out more particularly the varieties of country in which travel is to be performed.

Rivers and marshy grounds offer the natural obstacles to land-travel, of which, perhaps, our youthful readers will the most readily form ideas. Most of them, we imagine, know very well what it is, either to be stopped by the water of a simple brook, or to sink and be distressed in wet and miry situations. In such cases they have only to fancy the small brook expanded into a large river, and the wet grass and mud into a wide morass, in order to become sensible of the value of bridges and causeways, by means of which they so often cross rivers, and proceed comfortably through morasses, without thinking for a moment of what would otherwise have been their difficulties, or of the great works of art from which they derive such advantages.

Of bridges and causeways we shall treat hereafter; but let us think, for a moment, of the natural difficulties of travel over the tops and sides of lofty mountains, in the hot or cold climates, in the midst of summer, or in the depth of winter. What heights to climb, what rocks to be passed by, what precipices to be avoided; and, when the snow is upon the ground, what depths and pitfalls of this snow, accompanied with a freezing air, and, perhaps, with raging winds! Of travel among the rocks and hills of Norway, of the west of Scotland, and of Switzerland, we shall presently see more; but even the plains and valleys, when covered with snow, have difficulties of travel which are to be overcome or lessened only by contrivances of art, of which the sledges of the Laplanders are a well-known example.

The mountains, still more difficult to traverse when covered with snow, which distinguish Switzerland, Norway, the Scottish Highlands, and many other countries, of which the names are less familiar; these will claim several of the future pages. At present, we mention only one or two mountain-passes, from which even a summer's sunshine, if unaided by the work of art, cannot take away the terrors.

There are few places, even among the passes of the Alps, more wild and romantic than the Via Mala, where a deep hollow is formed between the bases of mountains, rising to the height of six, and even of eight thousand feet into the heavens, on either side of the torrent of the Hinter Rhin. The entire length of the valley is nearly four miles; and the contrast of its general repose with the sudden terror of the Via Mala, or Bad Road, give it a character of beauty which it would not otherwise possess.

The Via Mala is part of a road now carried across Mount Bernardin, and executed by the canton of the Grisons, with the assistance of the king of Sardinia; both Sardinia and the Grisons, as well as other districts, expecting to profit by it, through the transit of merchandise by this means, from the ports of the Mediterranean into Switzerland, Germany, and Holland; and the canton of the Grisons comprising a great part of the ground to be traversed upon both sides of the Alps.

From Coire to the summit of the Bernardin, a distance of fifteen leagues, the road rises five thousand one hundred and thirteen English feet; and from the summit to Bellinzona, a distance of eleven leagues and a half, it descends six thousand two hundred and eighty-nine feet.

At Richenau, on the road of which we are speaking, the two streams called *Vorder Rhin** and *Hinter Rhin*†,

* Foremost, or Further Rhine. † Hinder, or Hither Rhine.

unite; and here is a bridge of a single arch, two hundred and thirty-seven feet in span, and eighty feet, at its centre, above the water. The bridge is covered, and, built entirely of wood; and is one of the most celebrated and remarkable of this description of bridge at present existing.

The Via Mala.

After passing, by another covered bridge, the stream of the Hinter Rhin, we enter the beautiful valley of Domleschg, through which an excellent road carries us to Tusis, a town at its southern extremity, and close to the Verlohren-loch, the entrance to the Via Mala. Before the year 1470, there began, at this point, only a pass for mules, which avoided the gorge of the Via Mala; but now a shorter communication was opened, descending six hundred and eighteen feet into the gorge, and continued by means of hollowing out a path upon the eastern side. In 1738, the road was improved by altering part of its course to the western side, and by building two bridges, which were boldly thrown across the gulf below. It was the part constructed in 1470 which first took the name of Via Mala; that of the whole ravine being Verlohren loch.

When the establishment of a carriage-road by the Bernardin was resolved, Pocobelli, the engineer, directed his particular attention to the entrance of the Verlohren-loch, by the side of Tusis, and determined to carry the road through the tremendous obstacles which opposed him there. The success of his enterprise was complete. A well-made road is now extended across the Nolla by a new bridge; thence it is carried round the eastern side of the ravine; and, where the projecting and perpendicular rock overhung the torrent three hundred feet, a gallery or tunnel has been cut through it, two hundred and sixteen feet long, fourteen feet high, and eighteen feet wide.

The scene immediately around this spot is exceedingly grand. In many places, where the road is carried three or four hundred feet above the river, the sides of the ravine are not fifty feet apart; and the width of the gulf never exceeds a hundred and fifty. The rocks, in the mean time, which tower a vast height above the road, and overhang the mighty depths beneath it, oppress the mind of the spectator, through his difficulty, in the narrow passage, to discern the end, either of the height or of the depth! The narrowest spots have naturally been chosen for the sites of the bridges; but here, too, from the narrowness, the rush of the water is the most fierce; and, from the bridges, it requires a firm head to look down upon the latter steadily. The roar of the waters diminished as it ascends from their deep-sunk surface, reaches the ear only in murmurs: and, when discerned in their dark abyss, they appear to send up a white foam along the ravine, produced by its boiling eddies.

Our next example comes from the Alpine scenery upon the sea-coast of Italy.

"A Genoese," says a writer, "will tell you, you have a lovely road from Diana to Saint-Remo: the postboy rides in the night very often, and falls asleep. Now what would you imagine this road to be? A million sterling could not render it *tolerable.* Indeed, none but the natives are obliged to pass it, except the postboy, now and then, and the sea-sick. It serpentines on the side of a ridge of rocks, which, every ten minutes, hangs over the sea, as high, perhaps, sometimes, as the cupola of St. Paul's is from the ground. You have a wall of rock above you, and a stony track for the mule, about twelve or fifteen inches wide. If you turn your head a little back, when you clear any angle, you may see the sea under your beast's crupper:—on your right hand, a perpendicular wall of rock; on your left, waves roaring and dazzling beneath you. To mend the matter, the mule always chooses the edge of the precipice; because, when she carries bales of goods, if she strike against the side-wall, it might overset her in an instant. If the guide sees you timorous, he denies you a bridle, for the least check, through fear, would send beast and rider both down the precipice!"

But, though the mule is a beast of burden which, in almost every instance, is the surest-footed of travellers upon these difficult roads, there are situations in their course, where men may better trust their own feet than those of their mules.

Above Hendec, in the Pass of the Grimsel, in the Alps, the road, half a league from the Châlets, rises high above the torrent of the Aar; and on the brink of a precipice, crosses curved and inclined surfaces of granite, of great extent, and worn to extreme smoothness by the descent of avalanches, which, from time to time, have also swept away the barriers raised to guard the traveller in this fearful part of the passage. Here, too, the danger is further increased, when wet has fallen, and a frost has followed the wet; and it is usual, therefore, to dismount at this place, because a man can walk over the masses of rock with greater security than a mule; and a single slip of the foot of the latter must be destruction to the rider, no less than to the beast. Upon one occasion, however, a visiter insisted upon riding, in spite of every remonstrance of his guide; but the mule (less able to take care of itself upon account of its burden) slipped, as the guide had too truly expected; and though the guide, by seizing the obstinate man's clothes, saved the latter, yet the mule fell over the precipice into the gulf below, and was killed and shattered to pieces by the fall. The traveller's feet were out of the stirrups, or he must have perished also. The largest of the masses of smooth rock is a hundred and twenty feet across, and is called Höllen-Platte, or the Devil's Platter.

An accident somewhat similar befell Napoleon Buonaparte, during his extraordinary passage of Mount St. Bernard, in the year 1800. In a dangerous part of the way, near the termination of the Forest of Saint-Pierre, he slipped from off his mule, but was saved from falling over by his guide, who, as in the former instance, caught hold of him by his coat. The guide was rewarded with a present of a thousand francs.

To change the scene, and to show how pleasant, comparatively, the travelling upon the Arabian deserts, at the favourable season, may sometimes be found, we will make a few quotations from the excellent account of a late journey from Damascus to Bagdad, across the Desert, in company with a numerous and well-armed caravan. In the experience of our present traveller, the route is made to appear a very passable, even if not a very amusing ride, of about twenty days' duration.

"I must give a description of our equipage, now that we are fairly launched on the great waste. I ride a white camel, with my saddle-bags under me, and a pair of water-skins, quite full, beneath them: over the saddle is my bed. A thick cherry-stick, with a cross at the end of it, serves to guide the animal; a gentle tap on the side of his neck, sends him to the left, and one on the opposite makes him turn back again to the right: a knock on the back of his head stops him, and a few blows between the ears bring him to his knees, if accompanied by a guttural sound, resembling, as the Arabs say, the pronunciation of their letter *sche.* To make him move quickly, it is necessary to prick him, with the point of the stick, on the shoulders.

"To the north there is a range of bare hills, and at their bases are patches of green; the rude tents of a tribe of Bedouins are pitched, and their cattle enliven the scene. We passed over a perfect level this morning, strewed with flowers, and thick with pasture for the camels, where we are now resting. It is not usual here, as in many parts of the east, for the camels to wind in long strings, one after the other. Our numbers, amounting to fifteen hundred, are scattered over the surface in all directions, as far as the eye can trace.

"In travelling, the sheikhs or chiefs of the caravan, attended by the military part of their equipage, mounted on dromedaries, move in advance, while the loaded camels follow at some distance, in parallel masses, opening out, or changing the form, as the grass renders it necessary. They fall so naturally into military figures, that it is difficult to conceive their doing it without direction.

"We have several tents in the caravan. They are pitched so as to permit the camels belonging to each to lie in the intervals, where they are placed in *squads* for the night. They are by no means agreeable neighbours: for, although they are not able to move from their place, they make a most unpleasant gurgling noise*; the bales of the merchants always form the windward defence, for the tents have no sides to them, and but flutter over the goods to keep the sun from their owners.

"At the usual hours of prayer, a loud call is heard throughout the camp, and parties flock to where the Muezzin takes his stand. At sunset, as the camels draw in from the pasture, all the Arabs are on their knees, in a line of two or three hundred, in two ranks. The priest, like a fugelman, in front, gives the time for bowing their heads, and performing the rest of the enjoined ceremonies. As they rise on the signal, they sink again to their knees, and press their foreheads to the earth

* Is this in chewing the cud; that is, (with camels,) in digesting and changing the situations of the food, in their five stomachs?

with the utmost devotion; the scene is singularly impressive.

"The rate at which a loaded camel travels is estimated at two miles and a half an hour by almost every traveller. Our caravan has not, I think, exceeded this; but the variety of its movements has been very tiresome. The Arab drivers, who walk in front of the animals, never miss an opportunity of a piece of pasture, but, however distant it may be from the proper course, lead them towards it, and, with the short sticks they carry, beat them into the thickest part of it. The camels are anxious enough for the matter themselves, and huddle so together that their riders' legs are in tolerable danger of being crushed in the contact.

"There is so strong a resemblance to a voyage at sea, in a passage across the Desert*, that I cannot divest myself of the belief that the moving mass is but a collection of small vessels, carried into a heap by the tide. Every man is ready with his stick to fend off the animal that approaches him; one push separates the camels as it would separate a couple of boats, and the camels move away quite unconscious of the circumstance, till another movement swings them together again."

"Very little," says Major Skinner, upon another occasion, "serves to give interest in the Desert." The two small incidents, however, which follow, serve not only to illustrate the general manners of the Arabs, but also some of the features of a journey with a caravan.

"April 8th. We are obliged to halt this day, and have learned the cause of the short march of yesterday. A very fine gray mare, belonging to the Sheikh, foaled during the night. He gave a feast, in celebration of the

* One of the well-known figurative names of the Arabs for the camel, is that of "Ship of the Desert."

It is a verbal coincidence, but nothing more, and yet striking for a sort of reversal of the image, that in Europe we have a machine called a "camel." But the allusion, in this latter instance, is only to the machine's lifting a ship upon its back, by rising with it toward the surface of the water; as a camel rise from his knees after he has received his load.

birth, to the principal people of the great tribe of Anazie, now in our neighbourhood. The festival has created some merriment in the camp. Fires are blazing all around, and knots are seated in different quarters, smoking, cooking, or eating.

"The drivers are the poorest and lowest of the tribe, and exercise the sticks they carry with very little ceremony. For example, I was in the act of drinking water, with the flask applied to my lips, when my camel, receiving a blow for going where he should not, turned suddenly round, and I came in a sitting posture to the ground, amid the laughter of the whole of my part of the caravan. I contrived to meet the fall; and, without having moved my flask, continued to drink. I received an Arab cheer for this feat; and, when I remounted, several came to congratulate me on the ingenious manner of my fall. One Arab, who had travelled a great deal in Syria, and had seen many Franks*, assured me that I was more fit to be an Arab than any other Frank he had met with; for Franks, he said, were all excessively awkward and disconcerted when they fell. I do not mean to take much merit to myself for this act of agility, or to recommend it to the practice of travellers; but it has positively gained me more good will from my wild companions, than the most sedate demeanour could have done†."

The following will mitigate any ideas of uniform horror which we may entertain concerning the Arabian wildernesses, and the situation of those who have journeys to make upon them.

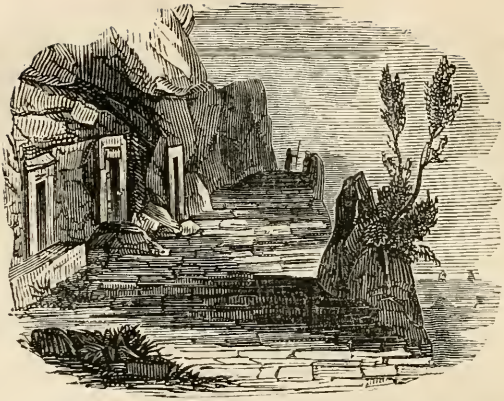
"April 12th. I am so pleased," says Major Skinner, "with the independence of the Arab life, that I think I could submit with good grace to such a lot for a few months. When the Desert ceased to be, as it now seems, a garden, I should probably change my mind; but at this

* *Frangi*, *Fringi*, or Europeans; so called by the Eastern nations, from the word *Frank*, or French; their earliest acquaintance with Europeans having been with the Franks, or ancient Frenchmen, who, coming from Europe, were considered as Europeans in the total.

† Skinner's *Journey Overland to India.*

moment the mildness of the climate, the immense extent, the richness and fragrance of the plain, render the life I lead most delightful. I was obliged this evening to pluck up a large bed of mint, before I was able to spread my carpet, the odour being too strong when pressed by my weight; it is like the most powerful essence of peppermint, and is in very great quantity around."

We have thus glanced at the facilities offered to man and animals in moving over the surface of the earth. We have seen that many obstacles are opposed, and many difficulties to be overcome, and that the modes of travel are as various as the nature of the soil upon which man travels. Let us now proceed in a more methodical order: let us trace the progress of roads and bridges; canals and tunnels; carriages and vehicles of every description, from ancient times to our own day, until we arrive at the last grand improvement in locomotion, in which animal power is superseded by the new and wonderful adaptation of steam. We must visit many lands in our progress, and become acquainted with many nations; but our course will not be uninstructive, nor devoid of entertainment: it will teach us to prize the blessings of civilization, to admire the progressive ingenuity of man; and the moral will be, that, in virtuous industry and enterprise, nations as well as individuals find their happiness and general well-being.



Road of Antoninus

CHAPTER III.

Ancient Roman Roads.—Prætorian, or Military Roads.—Consular, or Public, or High-roads. — Vicinal, or By-roads. — Ancient Roman Roads in Italy, France, Spain, Syria, and Great Britain.

The beginning of roads is as ancient as the first movement of animal life upon dry ground; for all animals, by the treading of their feet, make roads spontaneously. Hence, the first roads that were made by men were properly paths, or foot-ways; and they afterwards grew in length and breadth, in hardness, smoothness, and all other perfections, in proportion as cities, towns, and other places of human dwelling and resort, were multiplied and frequented. The Indian paths of America, which are only broad enough to admit of one person following another, are examples of the primitive roads; and the tracks with which we are so well acquainted, across our fields and commons, and through our woods and coppices, are similar examples still nearer home.

But the practice of road-making, usually so called, began only when men first added to the spontaneous treading of their feet the skilful labour of their hands, in the formation of these important instruments of human intercourse and motion. This beginning we must date from the commencement of civilization; and as to the further progress of the art, and its achievements, this, in all countries, must have kept pace with the advances of that civilization; or, in other words, of their populousness, industry, ingenuity, and wealth. It follows, then, that in all countries, however ancient, where these means have been possessed, there have been roads adapted to their several purposes.

Of the roads of ancient Greece, historical notices remain sufficient to show that they were proportional, upon one side to the state of civilization, and upon the other to the narrowness of the territory of the busy and enlightened countries composing it. In ancient Egypt, the frequent historical references to its horses and chariots, no less than to its great cities, its general luxury, and even to its roads, leave us no doubt concerning its advancement in this branch of civilization; though it seems that in the times of its later and highest prosperity, it sacrificed its roads, its chariots, and its horses, to canals, conjoined with the navigation of its river. Phœnicia, so renowned in arts, and likewise in commerce, both by land and sea; the whole of all that was fertile in Syria; the pompous empires of Assyria and Babylon; the active populations of Persia, and of the countries bordering on it, and from thence to the soil of India, have all of them their antique attestations of important and well-frequented roads, for the convenience of the soldier, the pilgrim, and the merchant. Such is, for the most part, found to be the case, wherever the sandy surfaces of trackless deserts did not interfere with their structure and maintenance, obliging those that travelled to rely only upon the heavenly bodies, or upon the compass, as guides to the places which they desired to reach.

It would be easy to enlarge upon the history of ancient roads by referring not only to those in the Old World, but even to those of Peru and Mexico in the New World. In arriving, however, at Carthage, from which the Romans are said to have derived the knowledge and practice of that stupendous system of road-making, with the history of which we are so well acquainted, and of which we have still so many opportunities of examining the remains; we may here contract our view, and content ourselves with a few chapters on the roads of antiquity, and then pass on to the more modern roads of our own country, as well as to those of foreign lands.

The Romans had roads exclusively military, as well as all those which are known among ourselves. Their military roads were called Prætorian roads, as being under the immediate government of the Prætors, or military superiors; while their public or high-roads were called Consular, because made and maintained by the authority of the Consuls: and to each of these respectively was usually given the name of the particular Consul under whom it was first made; as in the examples of the *Via Aurelia*, or Aurelian road, made under the Consul Aurelius; and the *Via Appia*, or Appian road, made under the Consul Appius. Their by-roads, or roads leading from the Consular roads only to small places, or vicinities, or neighbourhoods out of the great lines, were called Vicinal roads, or *Viæ Vicinales*.

What was peculiar consisted in the usage of keeping the Prætorian, or military roads, or roads designed for the marching of soldiery and armies, entirely distinct from the Consular, or public, or high-roads—roads designed for traffic and for general purposes. The objects of the first were military dominion, and the immediate affairs of state, while the objects of the second concerned commerce and the general intercourse of Romans and strangers; and the separation was so strict, that where roads for all these purposes were wanted to and from the same places, still the two different descriptions of road were formed and carried more or less by the side of each other; as in the modern world we may now sometimes see our roads and canals, common roads and rail-roads, running side by side.

But the manner of making the Prætorian and Consular roads differed as much as the purposes for which they were made. The Consular roads were often more remarkable for their magnitude and breadth, for the persevering boldness with which they were carried in straight lines over surfaces of every kind, and for the variety of accommodation they afforded to passengers, than for smoothness or for general ease of travel. The centres were raised and paved with stones or otherwise provided with hard materials, while the sides were more or less of unmade earth. These raised and hardened centres were of the same general kind as the modern *chaussées* of France and *causeways* of England. In their general figure, too, they must have agreed with that of the many broad openings still to be seen in several parts of England, where a narrow causeway in the centre has wide spaces, or water, or mire, upon each side, serving for the traveller's use, when and where convenient; and in a more general manner for the pasturage of a cottager's cow, ass, pig, or goose. But the causeway in these Consular roads was sometimes twelve feet in breadth. For the making and repair of these public roads, the needful expenditure was levied upon the owners of the lands through which they passed; and while to the entire road was usually given the name of some particular Consul, or Pro-consul, as stated above, the particular parts were called after the names of these landholders respectively. From these statements it must appear that no tolls were collected, but that the cost and labour of these roads were provided for in Roman Europe, as till lately in all modern Europe, under a system more or less resembling that of the *corvée* in France, and of *statutable labour* in England, and which is the same with the system to which we shall hereafter refer in an account of the roads in Norway. There were no turnpike gates (those objects so long and so angrily decried upon their first introduction into England); but in order to enforce the Roman law, which required the land-holders to maintain the roads, inscriptions were established along the road-side, showing upon whom the responsibility rested. These inscriptions stated the divisions of the road, the names of the land-holders, the extent of their possessions, and the consequent duty to be levied upon them.

Of these Consular, or public, or high-roads of the ancient Romans, many considerable remains are still to be seen in every part of that which once constituted the

Roman empire. The Via Appia, which departing from Rome extended to the distance of 350 miles, and then terminated at Naples, had a causeway or pavement twelve feet broad, composed of square blocks of freestone, each for the most part a foot and a half in measure; and this road, now 1800 years old, is still, for several miles together, in many parts of its line, as sound as when first made. It is not everywhere, indeed, the smoothest of roads, but this we may believe it never was. Horace* himself was of opinion that it was best to go slowly over it; and this was at all times, doubtless, the case with the Consular roads in general. However superior they were in solidity, they probably resembled, in the article of smoothness, the modern roads or causeways of France, and required strong carriages as well as patience under jolting in order to be travelled. The modern road in the same direction as the Appian, though less adapted for great durability, is excellent in every particular that can recommend it to those who have to pass over its surface.

In the vicinity of Lyons, in France, exist the remains of Roman road-making, composed of beds or masses of flint-stones not bigger than eggs, laid in mortar, and from twelve to fifteen feet in depth, and as hard and compact as marble. After a period of 1600 years from their formation; it is still scarcely possible to penetrate or disjoin the masses by any force of hammers, mattocks, or other tools. The Romans always laboured at establishing the solidity of their roads, first by ramming or beating the native soil, and next by spreading upon it layers of flints, pebbles, or sand; and sometimes by adding masonry composed of hard rubbish, or of bricks, all bound together with mortar.

As to the public roads in general, their remains are regarded as monuments of the good sense of the ancient Romans, and of their care to provide for the accommodation of travellers. On each side was an elevation about

* "———Minùs est gravis Appia tardis."
Sat. Book i. 5. v. 6.

"The Appian road is less fatiguing to people who travel slowly."

sixteen inches in height, and nine inches in breadth, called *crepidines*, or parapets; and at the distance of little more than five yards were regularly placed on this parapet, large stones, each of the size of nineteen inches square, and twenty-seven high, for the convenience of passengers as resting places, or to assist them in mounting their horses. The road was higher in the middle than on the sides, and there were channels with small arches, as at present on our roads, for carrying off the water which drained from it into the adjacent fields.

In the streets of Pompeii, holes are to be seen in the parapet, made for tying horses or beasts of burden; and possibly the same practice was adopted on the high-roads; but Caius Gracchus, about 130 B. C., is said to have been the first to join the roads together by bridges, where such valuable accommodations were needed, and also to drain them by subterranean channels; and to him also is due the introduction of mile-stones, which everywhere indicated the distance from Rome. On the road to Naples, all these mile-stones were placed on the left of the traveller who was on his way thither. The inscriptions on the bridges were engraved on each side. A military column or standard mile-stone, denominated *miliarium aureum*, or golden standard, or mile-stone, was erected in the Forum, at Rome; as the centre whence proceeded the roads which spread from it. Most of the consular roads led to sea-ports.

But many of these roads were double; that is, they had a carriage-way upon each side paved with stones, for the use of carriages moving in opposite directions; and each separated from the other by a raised foot-way, paved with bricks. Add to this, that their whole line was studded with mounting-stones or horse-blocks, and with *miliary* or *mile*-stones.

The consular roads were also sometimes double in a more extended sense; that is, there were two roads to and from the same places. The intention appears to have been the safety of commerce and of travellers; as when, in the direction of sea-ports, one road was carried inland, and the other along the coast. Of these double roads between the same places, we may cite, as an example, the Via Appia and Via Domitia; the first leading from Rome to Puteoli through Capua; and the second through Cumæ and Baiæ. A poem of Statius is extant, which describes fully this latter.

Another species of Roman road was the *subterranean;* or road carried like our modern galleries or tunnels, *underground;* but for the sole purpose of shelter from the sun. These, of which the invention has been referred to the Egyptians, grew up among the Romans in times of luxury, and numerous vestiges of them are still found in different parts of Italy.

The Prætorian or military roads, upon the formation and good repair of which depended, in so great a degree, the acquisition and maintenance of conquests abroad, as well as the enjoyment of security and peace at home, were still more decidedly the care of the Roman government. For the most part, they were, at least, sixty feet wide; of which space the elevated centre occupied twenty feet, and each of the slopes twenty more. But of this it would seem that only a part was paved; that is, imbedded with great stones in the centre, while footways upon each side had also their stone-pavements. Stirrups not having been yet invented, the stones for mounting horses were always an important part of the accommodations of the Roman roads; and along the Prætorian roads these stones were placed (we are told) at intervals of only ten feet. But did not these mounting-stones supply the further purpose of our ordinary posts, protecting the foot-ways against the horse and carriage-ways? The materials employed in making and repairing the roads, were such as the country through which they passed, afforded.

The Vicinal*, or country, or cross-roads, crossed the military roads at right angles; and at such places where four roads were thus made to meet each other, square gate-houses with arches opening upon each side, were built.

Roman streets or roads, as to their construction, have

* The *Viæ Vicinales,*—Vicinal or neighbouring roads,—were sometimes called Viæ *Patriæ* or *Country* roads.

been divided into three kinds:—the first, or simple *stratæ viæ*, paved roads, were formed only of pebbles and gravel; the second, or *viæ silice stratæ* paved with flint-stones, of large but unequal sizes; and the third, or *viæ saxo et lapide quadrato stratæ*, paved with square flat stones, laid down with regularity.

In some of the remains of Roman roads four strata or beds of materials are discovered:—in the first place, the foundation, which is quite sound, all soft or unstable earth having been carefully removed; in the second, a bed of broken earthenware, tiles, and similar materials, joined together with cement; in the third, a bed of mortar; on which, fourthly and for a completion, was laid the uppermost stratum, consisting of bricks, tiles, stones, or other convenient substances.

It is worthy of remark that, after the lapse of many centuries, during which most of our modern roads have been formed, the imperfections of which, had long been felt as a serious evil to the whole kingdom, good *paved* roads have been at length formed, by adopting the plan of the ancient Romans. Many of the new *pavements* of London are now based upon broken granite, instead of loose earth, which constantly works through the interstices, and interferes with the solid bearing of the stones upon each other;—to say nothing of the vast quantities of mud thus produced.

In other instances, the Romans paved their roads with stones, which they joined by means of a cement of sand and clay. A mixture of this kind is what is now used for many purposes in England, under the name of "Roman Cement."

Roads of the former kind were raised in the middle and laid with flags, or flat stones, for the convenience of foot-passengers; while the two sides were formed of sand and loamy earth, that they might be soft for the feet of horses; though horses were not anciently without shoes, as some antiquaries have imagined. The second kind of roads, made wholly of sand and clay, were convex in their form, to keep them dry.

The Foss-way, discovered in Wiltshire, is regarded as one of the many Roman roads in Great Britain; upon being cut through at a part of its line, it was found to have been constructed thus:—first, a foundation of flat stones; then eighteen inches of earth and rubble; and above this a course of small stones, with large fixed stones upon the surface.

On another ancient road in the same part of England, a layer of small stones was found at the top, then a layer of stone grouted or pounded; and, beneath the latter, a foundation which the soil concealed. These layers composed a mass which was cut through, to the depth of six feet and a-half, by four paces wide.

In low and marshy grounds the Romans took great care to secure their roads against injury by floods; and raised them, where the level required it, five, ten, and sometimes twenty feet high, that the waters might never rise above them.

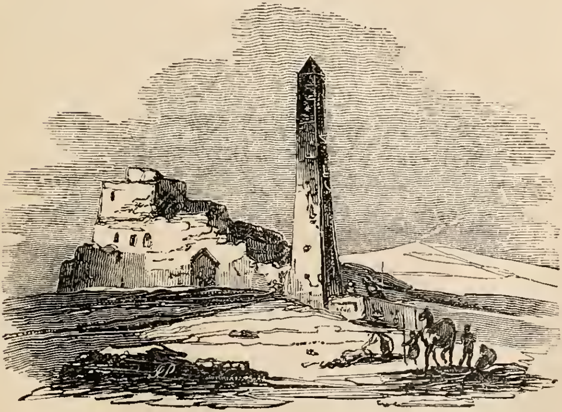
The remains of Roman roads are still very numerous in our island. I shall speak of them again, in conjunction with the ancient British roads, or roads constructed by the Britons, either before or after the establishment of the Romans among them.

The north as well as the south of Great Britain has its share of the remnants of Roman roads. In the east of Scotland they have been traced as far as the county of Angus, where they are regarded as affording traces of the Roman province of Vespasian.

The Roman wall with its military road, (similar to the Chinese wall,) which separated Roman Britain from the Picts and Scots, and which is called the wall of Antonine, is well known. But if, leaving all further consideration of Roman roads in Britain, Germany, Switzerland, Gaul, Spain, and Italy, and other countries of the west, we direct our attention for a moment to the Roman Empire in the east, we find there, too, food for historical recollections of Roman roads, and even actual remains of those great works. One of these latter, the road of Antoninus Pius, before alluded to, affords the view at the head of this chapter, as it is seen along the sea-coast near Baireuth, in Syria.

In modern Syria, no less than in modern Egypt, the spirit of enterprise and improvement promises the speedy construction of new and important roads; such as may furnish extensive means of communication, even if their quality should be less durable than that of the ancient roads. In Egypt, as has been long known, an excellent road between Cairo and Alexandria is at this day travelled by public coaches, built in England, drawn by English horses, wearing English harness, and driven by English coachmen; and in Syria, according to a traveller whose agreeable volume has already afforded us some descriptions of travel in that part of the world, "Ibrahim Pacha has a very fine scheme in his head. Should he secure the possession of Syria, Tour (the ancient Tyre), is to be the port; and a grand *road* from every part of the east is to be made to it*." The writer means that *roads* from every part of the east, are to be made to *meet at that place*.

* SKINNER'S *Journey to India*.



Cleopatra's Needle.

Course of the Wans Dyke over St. Anne's Hill.

CHAPTER IV.

Ancient British Roads, and Ancient Roman Roads, in Britain.—Degrees of Civilization among the Ancient Britons.—British Roads, and sites of British Towns, Villages, and Burial-places, in Wiltshire.—Course of the Wans Dyke from Andover to the Bristol Channel. — Belgic Kingdom of King Divitiacus.—Ancient History of the Road now called the Great Western Road.—Dykes and Ditches, Fosses and Moats.—Grim's Dyke.

When we glide over the smooth and spacious roads of modern Britain and Ireland, our thoughts are but seldom carried back to the narrow, rugged, and uneven roads upon both islands, which we shall have to advert to in the present and succeeding chapter: or to the contrast of the objects that lined them, or were visible from them anciently and now. In the aspect of nature, with regard to these objects, how striking is the difference between the castles and the cabins of times past, and the palaces, the villas, and the cottages of times present! between the wild moors of old, "immeasurably spread," and the swelling lawns of parks, with their beautiful drives, and tasteful entrance-lodges, which so often embellish at once the private and the public road!

We are not to think too meanly, however, of our native roads in Britain; roads begun and completed in times which probably go back to the highest antiquity. There were no Roman roads upon the island until the time of the Emperor Claudius, about 45 A.D.; but there were many British roads before the Julian invasion. We are accustomed to hear so much of the very rude state of the Britons two thousand years ago,—of their painted bodies, wicker coracles, and woodland huts,—that we often fail to remember that these descriptions, in all their rigour, apply only to parts of the people and to parts of the island, and afford no just representation of the whole of either. Cæsar states the condition of the Britons, in Kent, to have been found by him very similar to that of the Gauls upon the opposite side of the Channel; and from what we know of the civilization of ancient Gaul, Britain, no doubt, as seen by Cæsar, was sufficiently barbarous; but it was not *savage:* and in the estimate made of its advancement, there must be allowances for mountainous and other poor and thinly-inhabited situations, for remoteness from the sea, and for the very absence of roads,—where they were really absent,—and for the differences between kingdom and kingdom, or region and region, upon our soil; as also for the differences of rank and property in society,—for Britain, or parts of Britain, possessed, at the era in question, kings and hierarchies, nobility and land-owners, and, doubtless, merchants, slaves and a commonalty, in greater or less degree, the property of men of wealth and station. A wide distinction, indeed, is to be drawn between the Britons whom Cæsar found, and the Roman Britons, such as those afterwards became during the few centuries of Roman intercourse and domination: but Britain, before it was known to Rome, had its cities, towns, villages, and roads, and also its sea-going ships and foreign commerce.

"What the Britons," says Cæsar, "call a town is nothing more than a thick wood surrounded by a ditch and bank;" but Strabo gives us a better understanding of these dwelling-places when he observes: "Their towns are woods of a broad circuit, in the midst of which they clear away a part of the trees, and build huts, in which they and their cattle live together." Even here, we are to remember, nevertheless, that *towns* bearing this general description, might yet vary most considerably in extent, populousness, wealth, and the pursuits of civilized and even commercial life; from the rudest hamlet to ancient London, and other ancient cities of Britain,—cities which had their great roads before the first arrival of the Romans, and by the sides of which the Romans, where they did not adopt and improve them, were often content to make their own roads for their military purposes.

A *town* is properly an enclosure, or place defended against unwelcome intrusion, either by the simplest fence, or the strongest fortification; and thus it is that in Devonshire and Cornwall, where so much of what was anciently British, is still preserved, as well as in other parts of the kingdom, a farm-yard is still denominated a *town* and a *town-place;* and that by *barton*, *byre-town*, or *barn-town*, we are to understand a *byre-yard* or *barn-yard.* Now the *towns* of the Britons (like the *towns* of all other Celtic nations from Gaul and Italy to Britain and Ireland,) were circular*, and their *fortifications* (in defect of *walls* commonly so called,) consisted of circuits of thick, or, as it were, impenetrable trees, (called *silvæ impeditæ*, or thick woods, by Cæsar,) behind the outer circles of a bank and ditch, like so many of our rural defences to this day. But this very scheme of fortification is even now to be witnessed in central Africa, as that of very large *towns* (not to speak of them as *cities*); and it is always obvious, that these woody circuits, the cleared spaces, the number and condition of their inhabitants, and the number, size, and solidity of the dwelling-houses, and other buildings, sacred and profane, contained in them, might vary greatly.

An enlightened and indefatigable English antiquary, whose fortune and personal assiduity were long devoted (spade in hand) to exploring the earthen remains and monuments of British civilization and customs as still

* It is agreed that from the circular form of the ancient Latian towns, the Romans had their name of *urbs* (orbis), a town or city. The reader will see further, in the Latin word *urbs,* and its application, the origin of the English words *urban, urbane,* and *suburb.*

extant in the south-west of England, speaks thus of the ancient British roads, with the villages and towns in that part of the island:—

"These *ridge-ways*," he observes, "were the roads made use of by the earliest inhabitants of Britain, as lines of communication between their different towns and villages. They generally followed the highest ridges of land, on which also we find their habitations. They were not paved with stone and gravel, as in later times by the Romans, but their basis was the firm and verdant turf. It is somewhat singular that, even to this day, this original track-way* of the Britons may be traced over our Wiltshire hills for a very great extent, and throughout the whole of the adjoining county of Berks.

"In my description of the Marlborough station," he continues, "I mentioned the course of this ridge-way through it, and have supposed it to proceed from the southern ridge of hills, by a very ancient earthen-work, bearing the name of Broad-bury, across the valley towards Marden, between which place and Wilsford we have found pottery, and other marks of ancient residence. This line of the ridge-way is afterwards indicated by the names of Broad-street and Honey-street, and nature has formed an opening for its passage between two hills, each crowned with British remains. The one on the right, called Knap-hill†, has an earthen work on its summit,

* These *track-ways*, or traceable roads of the ancient Britons, are called *ridge-ways*, (as to those parts of them which followed,) as described in the text, the elevated *ridges* of land; but the author quoted, frequently calls the same pieces of road alternately *track-ways* and *ridge-ways*.

† It does not appear to have struck the writer, that this name of *Knap-hill* is obviously derived from the natural "opening for the passage of the British road between two hills," which is spoken of in the text. To *knap* is to break, or to cleave asunder; and is also the same word (though differently modified) with our modern word *snap*, and likewise *gap*. The Germans, also, have the verb *knappen*, to snap asunder with a noise. We find this word having a similar signification with the Flemish or Belgic *port* or *poort* used in the same sense in this sort of topography. *Nape* or *knap*, in the sense of an opening, hollow, or indentation, is the true origin of the term, the "nape of the neck;" for the nape

and two barrows within it; the other on the left, called Walker's-hill, has a long barrow* on its apex. Antiquities and barrows occur in the next valley, from which we re-ascend, and cross the celebrated Belgic boundary named Wans Dyke †. Hence the ridge-way descends into the vale of the river Kennet, which it crosses near the village of East Kennet, and pursues a northern course to the Hackpen-hill. Having traversed the turnpike-road between Bath and Marlborough, a little to the west of mile-stone LXXIX., it steers its course towards the Hackpen-hill, which is rendered conspicuous by numerous barrows of large dimensions which cross its summit; it continues on the ridge of hill overlooking the vale of Abury on the left, to the place before-mentioned, called Glory-Ann; then skirting Elcombe and Uscot Downs, it descends from them at the base of a hill on which Bar-

or knap, in this case, is the hollow cutting or indentation between the shoulders and the head; in the same manner that *insecta* or *in-sect* gives name to the class in zoology called *insects*, because of the *knap* or *nape* between the thorax and the abdomen, in so many of its species.

* Barrows, in Latin *tumuli*, are mounds of earth which distinguish ancient burial-places or *tombs*.

† There is believed to have been a Belgic invasion and settlement in this part of England about four or five hundred years before the invasion of Julius Cæsar; and the boundary between the invaders and the invaded is thought to have consisted in a line of defence composed of a bank and ditch, or what is still called in this part of the country, a *dyke* or *ditch* only. The numerous Belgic or Flemish words and proper names, both of persons and places, still preserved in the vicinity, seem to be monuments of the south of this part of British history; but our author is perhaps wrong in supposing Wans Dyke to be the British and Belgic boundary, at least, as far as its name may seem to import. Wans Dyke, or Woden's Dyke or ditch, is so named from Woden or Odin, the object of the worship of the Teutonic Anglo-Saxons, and not of the Celtic British and Belgæ British; Belgic and Anglo-Saxon names being intermixed throughout the country in question: and as to the compounds which include the Saxon and Scandinavian name of Odin or Woden, they are met with at intervals throughout the island; as Wednesbury, Wensley, Wenlock, Wanborough, Wantage, and Wanstead. Near Matlock in Derbyshire, there is a mine still denominated Odin's Mine.

bury Castle is placed, and beneath which, towards the north, there are the traces of some slight earthen-works. Though the track-way has been in some places destroyed by the plough, its course is well known, and again visible at the eastern extremity of a fine plain of verdant turf appropriated to the race-ground at Barderop. It continues its track through the dirty lanes, and an open arable country, to a place called Cross Bush, where it is again traversed by the Roman road leading from the station of Cunetio to that at Wanborough Nyth. From hence the ridge-way skirts the base of the hill on which Liddington, or more properly Brodbury Castle is situated, and is joined by another ancient track-way, which I have before mentioned as coming from Marlborough to this earthen-work. The old thorn-tree, as designated by the title of Ridge-way Bush is still in existence on the left side of the track-way, which shortly afterwards is crossed near a cottage called Totterdown, by another Roman road, coming from the station of Spinæ, near Spene, to the next station at Wanborough Nyth. The ridge-way now ascends Shelbarrow-hill, and having travelled through an enclosed corn-country, we leave the county of Wilts and enter that of Berks, a little beyond the village of Bishopstone*."

Wans Dyke, which, agreeing with Dr. Stukeley, this author supposes to have been the great Belgic boundary is spoken of by others only as an ancient sheltered or covered road. It consists of a vast dyke or ditch, by the side of which is a lofty bank or wall, or *vallum*, and is conjectured to have commenced eastward near Andover, in Hampshire. It terminated in the Severn Sea, or Bristol Channel, after a course of upwards of eighty miles through Hampshire, Berkshire, Wiltshire, and Somersetshire; for more than three parts of which distance it is still discoverable by the eye, while in many it is almost in perfect preservation. According to Dr. Stukeley, it skirted inland the Belgic kingdom established in Britain, of which the king, Divitiacus, finds a place in the *Commen-*

* Sir Richard Colt Hoare's *South Wiltshire* p. 46.

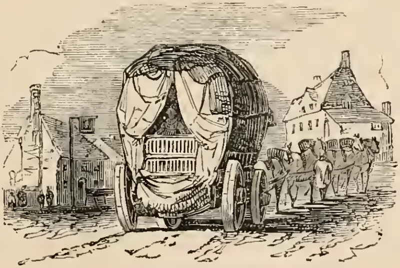
taries of Cæsar; whose name also, Divitiacus, is thought to be also still preserved in that of Devizes, at present but a market-town, though anciently (say the antiquarians) the capital of Divitiacus.

In the state in which Wans Dyke still subsists, and whatever people were its original constructors, it is supposed to have shared the labour of the Belgæ, Romans, and Anglo-Saxons, from which latter workmen it probably received its present name. Our author believes, indeed, that a considerable part of the present remains is to be ascribed to the Anglo-Saxons; and also that what was done by the Romans, had for its object the conversion of the dyke into a road.

"In the year 1817," he observes, "a very satisfactory discovery was made on the line of the Wans Dyke, which evidently proved that this *agger* (bank, wall, or *vallum*), was at first raised to a certain height, and subsequently increased in altitude. This important discovery was made by digging through the Wans Dyke, to make a sheep-drove, when the evident marks of the first and subsequent agger were clearly visible, with the different strata of mould, chalk, and turf. The first probably raised by the Belgæ, the last by the Saxons."

The view at the head of this chapter represents the course of the Wans Dyke over Saint Anne's Hill, better known among the country-people by the name of Tan Hill, of which the other name is probably a corruption. Upon this hill, upon the sixth day of August annually, there is held a large fair called Tan-hill fair. The view is taken from the two barns upon the hill, which are the immediate site of the fair. They stand upon the very line of the dyke, and the spot affords "a most perfect and comprehensive view," says Sir Richard, "of this noble agger, which still preserves its winding, and irregular course over the elevated ridge of hill." At the end of the present chapter is another view of an adjacent part of the Wans Dyke, where it joins a Roman road.

There seems reason to believe that all the "Saint Anne's Hills," (of which there are many,) throughout our island are so called, from some dialectic corruption, instead of Tan Hills, or Tan's Hills; in which latter form, however, the sound approaches so nearly to that of Saint Anne's Hill, that the change may have been quite unintentional. *Tan* is described as the great object of Belgic worship; and the fair held annually upon this spot in Wiltshire is doubtless, (like our fairs in all parts,) a remnant of some religious festival; and a festival it may be believed of Tan or Tamarus, or Taranus, (Jupiter, or the Thunderer,) a name of the first sanctity in ancient Belgica*. By some, Wans Dyke is regarded as the real Foss-way, already spoken of as one of the four principal British roads; by the side of which, at a later epoch, ran the Roman road, (Via Badonica,) from London to Bath; both, in a general view, in the line of what is now the *Great Western Road.*



In order not to interrupt the course of our statements, and not wishing to overload these pages with notes, we have reserved for the conclusion of the present chapter, some curious information on the subject of dykes or

* Tan-fan, or Tanfanca, (Tanarus Fanus,) is spoken of by Tacitus as a celebrated temple of the Belgæ. The practice of dedicating hills, either natural or artificial, to the service of the Divinity, and of celebrating the worship of the gods upon their summits, has been universal among mankind, and to these practices are probably due the name of Barbury-hill, as also Tan-hill. Barbury is a corruption of Badbury; and Badbury implies the hill of Bad, Bod, Budh, or God; in which sense we have Gadshill, Gaddesden, and Gadsbury, in England; and Godesberg in Germany.

ditches generally, arising out of what has been already said respecting Wans Dyke in particular.

Wans Dyke, otherwise Wondes Ditch, as it has been already intimated, may be called Woden's or Odin's Ditch or Dyke. It is observable that the words *ditch* and *dyke*, (which are only the same word differently pronounced,) have two very different senses, as well as different pronunciations in different parts of the islands. In some parts, as in the south of England, a ditch or a dyke is understood to be a hollow, cut lengthwise in the earth, of various dimensions, either dry or wet, and intended either for drainage, demarcation, or defence; thus we speak both of wet and of dry ditches; and thus also in the military art, *ditch* and *fosse* are synonymous terms. In other parts of the island, however, a *dyke* is understood of a *wall*, or at least of an *embankment;* and thus the term *stone-dykes*, meaning commonly uncemented parapet-walls of unhewn stone, such as, upon rocky soils, are used for fences, and partitions of fields, instead of hedges, or other different materials. But in both senses, whether of a *ditch*, or of a *bank*, or *wall*, the words *dyke* and *ditch* have a common origin in the verb *to dig*, and imply a *digging;* the diversities of their senses and sounds depending as to the first upon the particular result of the *digging* to which the mind refers; and as to the second, upon the circumstance whether a *dyke* or a *ditch* shall signify something which is sunk, or something which is raised; but it is to be remembered that either has the proper signification of the *whole* of the work performed; or of that entire line of drainage, demarcation, or defence, which we sometimes (and accurately) call a *bank* and *ditch* together; after which it is left to different speakers, or to difference of local variations, to settle the term, and to choose a sound between that of the letter *g*, and of the letter *k;* between the hard and the soft sounds of both; and between the various alphabetical representations of these sounds, as *tch*, and *sh;* as, for instance, the word *dish* (a hollow vessel) is but a third form of the word *ditch* or *dyke*.

Then, as to the custom of applying the term *dyke*, or the term *ditch*, exclusively to the *ditch*, or hollow, or exclusively to the *bank*, or wall, we have to notice that both of these are *dug*, and both are dykes, ditches, or *diggings*, the one being the space whence earth has been *dug out*; and the other the space upon which is *raised up* the earth which has been dug out. The established application of numerous words to the exact counterparts of their literal and primitive meanings, is exceedingly common; and we have an example in one which is closely allied to that of the dyke or ditch. In England, most persons understand by the word *moat*, a sort of ditch surrounding a house and gardens; such house, (or moat-house,) being usually ancient, and of some ancient dignity. In truth, the *moat*, which at least anciently belonged to it, and whence it had its designation, was one of its means of military defence in ages when private persons had the misfortune to be obliged to live in "strong houses," or small fortresses. But was the ancient *moat*, the *fosse* or *ditch*, as at present understood? No; but the *mount* which had the fosse or ditch (now called *moat*) at its foot; and from which the enemy could be overlooked and assailed, while the fosse or ditch (now *moat*) obstructed his approach. Hence it is that in Ireland, and, in many instances, in England, a *moat* still signifies a *mount*, instead of a *ditch*, comformably with the real meaning of its original, which is the French word *motte*; for which both in England and Ireland, we are doubtless indebted to the Norman part of our ancient population. Wans Ditch, then, and Wans Dyke are names of the same signification; and may equally apply to the embankment above, or to the covered (that is protected) way below; and hence it is either a wall, or a way, or road; or, in other terms, a dyke, ditch, or foss-*way*, or a dyke, or ditch-*road*.

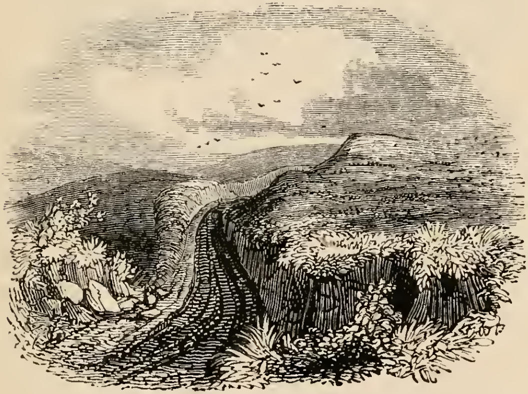
An interesting point connected with the supposed boundary between the Belgæ and Britons remains to be noticed. If it were necessary to find a Celtic name attaching itself to a dyke or ditch, which formed the supposed boundary between these people, this may probably offer itself in Grim's Dyke before referred to, which the country people of Wiltshire are frequently heard to speak of as *The Devil's Dyke*. *Grim* may be only another form of *Grin*, or of *Gryn*, (*Gryan* in the Irish, whence comes the Irish proper name of *Ryan*,) signifying the *sun**, and here used for the sun as a divinity, or as the object or symbol referred to in divine worship. What suggests the probability of such an etymology is the name of *Devil's* Dyke, otherwise borne by the same dyke or ditch: for if the Pagan inhabitants of the country called this ditch or dyke, the DYKE or DITCH of the SUN, as a title of sanctity, their Christian successors would assuredly call it the Dyke or Ditch of the IDOL, or of the Devil†; and if this origin of both words *grim* and *grin* be admitted, several other corroborative explanations will follow, especially of English proper names, alike of persons, and of places,—all connected with that solar worship which once stood so high in Britain, and not the lowest at the city of Bath, which place is in the part of England of which we are now speaking. Thus of "Grimshaw," (*shaw* signifying a wood or grove,) we shall make "THE WOOD or GROVE OF THE SUN. But what Grim, or Gryn, or Grynæus may have been to the Celtic races, the same was Woden or Odin to the Saxon; that is, SUN of the symbolical worship; so that with all the truth of poetry they could call a gleam of sunshine the "smile of Odin."

It must be my apology for making these references to the religious antiquities of our islands while directly concerned only with their *roads*, that the history of *roads*, whether ancient or modern, involves us deeply in the general history of the countries in which they are found; and that the history of all Pagan countries, and of all Pagan antiquities, also involves us deeply in all that belongs to the peculiarities of their religion. We must not, however, lengthen our chapter so far as to state the history of the reasons why the roads, ditches, walls, and boundary lines of Pagan kingdoms, have so many religious connexions. For the rest, we may venture to hope that these incidental contributions to the general

* The same with the Apollo Grynæus of classical mythology.

† Frequent allusions occur in the Scriptures to the heathen gods, as being *devils*.

ancient history of the British Islands, arising out of that of their ancient roads, will not be wholly unacceptable even in the midst of the immediate history of such ancient roads, which we will conclude in the next chapter. We shall, of course, be troubled with no such associations, when we come to speak of modern performances in road-making.



Junction of the Wans Dyke, and a Roman Road in North Wiltshire.

Ancient British Trackway.

CHAPTER V.

Ancient British Roads, and ancient Roman Roads in Britain concluded.—Four ancient British Roads from ancient London and its vicinities.—The Foss-way, or the Wans Dyke.—Watling-street.—Ancient sanctity of the spot now St. Paul's Churchyard.—Ikenild-street.—Ermin-street.—Statues of Ermin or Roland.—Differences between British and Roman road-making.—Roads, walls, dykes, and ditches.—Odin's Dyke.—Grim's Dyke.—Ancient British Towns and Villages, and their communications.—Wheel-carriages.—War-chariots.—Imagined terraces intended as roads upon the British hills.—Natural terraces in North America.—Ancient Peruvian and Mexican Roads.—Roads and City of Palenca, or the City of the Desert.—Ancient Roman and Ancient British Roads contrasted.

The Foss-way or Foss-road, or dyke or ditch-road, or the Wans Dyke, so frequently referred to under these various names in the last chapter, is one of the four great roads which departed from London before the time of the Romans in Britain; which roads constituted the southern, the south-western, the eastern, and the north-eastern, as at present. Their names, as transmitted to us, are Watling-street, Ikenild-street, the Foss-way, and Ermin or Herming-street. Verulam-street, which is less spoken of by antiquaries, was part of the present Great North-road, or which we sometimes call the Barnet-road, and Saint

Alban's-road; and had its ancient name from the ancient city of Verulam, nearly upon the site of which stands the modern town of Saint Alban's. Saint Alban's itself is sometimes still called Verulam; as in the case of the title of the illustrious Lord Bacon, which is sometimes spoken of as Verulam, and at others as Saint Alban's.

Of the four roads, that which is now called Watling-street is the one best known to modern Englishmen, or at least to modern Londoners; for there is still, within the limits of the ancient city, a street called Watling-street, a certain remnant of the ancient road or street, and situate near London Stone, the antiquity of which monument is not disputed; and which was probably the ancient standard, or point of departure, for the four several British roads. Watling-street has been so familiar to English ears, as a road of considerable extent, and, as it were, running through all the kingdom, that a poetical, and perhaps cockney astronomer of the last century, has ventured to call the milky-way, or thin starry band, or road, which encircles all our visible heaven,—" the Watling-street of the sky!"

That Watling-street had its origin before the Romans, or that it was what that people called a *via patriæ*, or country, or native road, at the time of their arrival, has never been controverted. In the Latin, Watling-street has the ancient name of Via Vitelliani, given, according to a French writer (who is a decided advocate of the British origin and denomination of the road), by the modern English antiquaries, through an eagerness to find that everything in Britain is Roman. But, if the word *watling* is really British, what can be more probable, than that the Romans themselves so corrupted, or, at least, so latinized that British word, as to make of Watling-street, " Via Vitelliani ?" As to the rest, a *wattle* is held to be the same thing as a *hurdle*, and always a species of *fence*, whether made with the small ozier, in the manner of basket-work, or with stronger pieces of wood, such as we see in the hurdles of sheep-folds, and even in fences still larger and stronger. Hurdles, therefore, or wattles, are the fences of enclosures; and according to the French (that is, the Breton) investigator already alluded to, Watling-street was so named by the Britons, because it was a *paved road, leading to a sacred enclosure**. He means, then, that it led to a *wattled* or *enclosed* space; or, more strictly, to the *wattles* or to the *enclosure.* But with respect to the *sanctity* of the supposed enclosure, were these *wattles*, or was the sacred enclosure our present St. Paul's church-yard, upon which Watling-street actually abuts; and which in the time of the Romans contained a temple of Diana, as, before the Romans, it had contained (we need not doubt) a temple of the Druidical worship?

Ikenild-street appears to be literally "the Essex road." It left London in an eastward direction, and penetrated into the country of the Iceni, or modern county of Essex. The name *Iceni*, upon the principle already adverted to of a variable and dialectical hard and soft sound, and convertibility of the letters *lc* and *c*, may be written and pronounced *Ileni.* M. Cambry, already quoted, thinks that, in the syllable *ild*, in Iken*ild*, we are to find the modern English word *old*, (French, *ancien*); but does not add whether by the name Ikenild-street, he therefore understands "the road of the ancient Iceni," or "the old Iceni road†." This syllable, *ild*, is to be met with in various orthographies, as *ild*, *ilde*, *eild*, *ield;* as is also the entire name. Thus, for the same street or road, authorities give us Ikenild-street, Ikenield-street, Ickenield-street, Ikenning-street, Hikenilde-street, Rykenield-street, and even Thenield-street ‡. In the passage of this ancient way or road through Berkshire, it is called "Ickleton-way."

* "Chemin pavé de l'enceinte sacrée; de *Wattling*, substantive et participle présent de *Wattle*, "claie," "fermer de claies:" d'où le plurier *Wattles*, "parc fait de claies."—CAMBRY, *Monumens Celtiques.*

† How is it that in the eastern part of London we have still our "Old-street," and also its derivative, the "Old-street-road?"

‡ This last, however, appears to be no more than an error of the press. It is found in BREWSTER'S *Encyclopedia,* a work abounding in the most extraordinary manner with errors of that description. If "Rykenield," or "Rikenield-street," which is more frequent, could be supposed to originate in a clerical mistake of *R* for *H*, then "Hykenield-street," or "Hikenilde-street," would only be "Ikenield-street," with an aspirated initial.

Ermin-street, or Herming-street, is described as an ancient road of considerable circuit. Departing from some point near London, it is supposed to have run, first, to Colchester, in Essex, (anciently a city of high rank, as well British as Roman); and thence to Carlisle, or, according to others, to Chester. The name Ermin, Herming, or Herminge, appears to be Saxon, and is derived from Ermin, the subject of the celebrated monument of stone, the Erminseul, and written in Latin, Arminius; called, sometimes, a Saxon hero, but at others, and with greater probability, a Saxon divinity; and the same it may be strongly suspected, with the equally equivocal Saxon, or generally German personage, "Roland," whose statue is so frequent in the market-places of Germany and Switzerland, and whose name is not unknown in France.

It will not be uninstructive to the general reader, if I here interrupt the prescribed order of my chapter, to introduce a few remarks on the subject of these famous Roland statues.

There is a Tour* Roland at Arles, on the Rhone, in France, called by another name, La Dominante. At Bremen, and in numerous other cities and towns in Germany and Switzerland, and particularly in Saxony, there are statues of Roland in the market-places.

"Who is this famous Roland," says the English traveller, Holcroft, "a figure of whom one meets at almost every town?" According to the popular account, "Roland" was a great champion, and one of the twelve paladins or peers of Charlemagne; and the same, we may perceive, with the Italian Orlando; but according to accounts that are preferable to this, these "Rolands" of the German cities represent no historical person whatever, but are merely the symbols of municipal authority, or of territorial jurisdiction or police. Rüge, in the old German, signifies a court of justice or of pleas; and Rügeland (*Rügeland*, *Rüland*, or *Röland*,) is a land, territory, or district, endowed with the privilege of holding such a court within itself, or of dispensing, within its own limits,

* Tour is the French for a *tower* or *spire*, and here implies a *statue*.

justice, both civil and criminal. Now this privilege or authority, and the determination to exercise it, was represented by a *town-statue*, a *weich-bild*, or statue of the highways and market-places; and these statues, or simple symbols of the privileged or incorporated cities or districts, are the Rülands or Rölands, or properly the Rügelands-säülen, or stones, or pillars, or columns of the several rügelands, communes or municipalities. Röland, or Rüland's statues, says a German writer, are statues of a man in armour, found in twenty-eight German cities. Der Röland, or Rüland, *ist ein riesen bild*, (is a gigantic statue,) erected in old times, (says a German lexicographer,) in the market-places of certain cities of Germany.

It would be easy to carry these explanations and this history much further; but we must conclude with the propositions, that a Rüland, or Roeland-säul, is the same with the well known Ermin-säul, so zealously destroyed by Charlemagne himself; and the same with a statue of Mercury or Hermes, the accompaniment (and for similar reasons) of Greek and Roman market-places and highways; and that, probably, two of these Rölands, or Rülands, or Ermins, (the apparent sources of the name of Ermin-street, or Herming-street,) are the originals of the famous giants of the Guildhall of our English capital: one representing the municipal authority of the city of London, and the other that of the county of Middlesex. Let us now return to our more immediate subject of ancient British roads.

In numerous other parts of Britain, besides those already mentioned, remains of ancient British roads are still subsisting, as well as of Roman and others which are proved to have had existence by their record in ancient writings; and they are found, as already suggested, sometimes accompanying, sometimes crossing each other; and sometimes the successive labour of British and of Roman hands. Their structure, their materials, the lines they follow, and sometimes their names, or the names of the places through which they pass, point out to the antiquary a portion, at least, of the history of their origin and later condition.

The Roman roads never deviated from a straight line; but where the surfaces opposed an impediment, the highest points of land, one after another, were chosen for surveying posts, whence another post at a considerable distance could be seen, and thus the direct line, was, as much as possible, preserved. "Sometimes," says the Wiltshire antiquary before quoted, "while speaking of the Foss-way, you are in danger of losing it through the many intersections of cross-roads; and sometimes it is enclosed with pastures, or passes under the side of a wood. Therefore, upon every hill-top, I made an observation of some remarkable object on the opposite high ground, which continued the right line, so that, by going straight forwards, I never failed of meeting it again."

The natural soil, (a gravel, where it was attainable,) and the verdant turf, were often the only surfaces over which the British roads proceeded, and the sides of hills or ridges of land, for the sake of their dryness*: and the natural openings between hills, for the facilities of passage, and all for the abridgment of labour and cost, and for the smaller demand upon science and skill, were usually the characteristics of British roads, while, in the Roman roads, we see the skill of the engineer, the rigour of a fixed system, a prodigality of labour and materials, a costly transport of the most serviceable kinds of the latter, a disregard of obstacles, a readiness to level heights, to run cause-ways through low grounds, and to open passages refused by nature; all which contributed to make these latter straight in their course, and solid in their substance. Many Roman roads in Britain bore the proudest Roman names, the Julia Strata, for example, "the *Julian paved* way."

In the east of Scotland we have, in addition to Roman roads, the *wall* of Antoninus Pius; a wall which, like that of China (though upon a scale so little comparable), was at once a wall and a road; nor will the numerous remains of Roman palaces, and of other works of strength and

* It is in situations like these that we find the British roads or *trackways* of the south-west of England, with the local denomination of *ridge-ways.*

grandeur, and the historical records of the residence of at least two Roman emperors in England (Claudius at Colchester, and Constantine at York), permit us to doubt, for an instant, anything that has been written, or anything which remains in substance, to attest the care of the Romans to supply this island with roads, as well as with so many other products of civilization, during at least the latter part of their continuance here, which exceeded altogether four hundred years. How many topographical names among us still conceal the testimonies of Roman labour, may be guessed from an example in North Wiltshire, where the name "Runway Hill" has received the scarcely disputable interpretation of Roman-way Hill.

In the mean time, while thus acknowledging our debts to our Roman benefactors, and specifically in the article of *roads*, it must not be omitted, once again, to take credit for the early British civilization as shown by *their* roads, to an extent not absurdly and visionarily extravagant, but such as may be well warranted by evidence and by reason. The evidence of names, supposed to be Roman, is not always to be trusted; and as an opposite example to that of Runway Hill, may be cited a road in Lincolnshire, called "Sarnelin" and "Sarn Helen" in English, and *Strata Helenæ* in Latin, and set down for a Roman road, named after the Empress Helen. But, if the conjecture of a living Gallic antiquary may be admitted, neither the Roman empress Helen, nor any other Helen whatever is concerned with this Lincolnshire road, and the name "Sarnelin" is a purely British compound. The British or Breton *sarn*, according to this writer, signifies the same with the Latin *stratum*, that is *pavimentum*, or a *paved* road or street; and *elin*, the Latin *cubitus* and *conversio*, in English an *elbow*, or *turning*, or *winding:* and thus "Sarnelin" becomes a curved or elbowed paved road or street*. It may be added to this, that many names of places throughout Britain have been thought to be of Roman origin, only because of a certain radical similitude of the Roman and British languages. The Latians or Latins, if not the Romans, were essentially as

* Cambry, *Monumens Celtiques.*

much Celts or Gauls as the Gauls in Gaul, or in the several Gauls, and as the British Gauls in Britain*; and of the Latians, or the Latins, the Romans received, among many other things, at least, a great part of their language†. With respect, however, to the single word *street*, employed in the sense of *road*, and occurring in its derivatives and compounds, in frequent examples, in our topography, and upon which such stress has often been laid, as inferring a Roman origin‡, there seems reason to think from the wide diffusion, either of the root of the word or of the Roman form of it, into both Celtic and Teutonic vocabularies, that its use may be as well attributed to many other people as to the Romans; and that perhaps our English term *way*, (from the Latin *via*,) as occurring in Foss-*way*, and in general application, is of more probable bequest to us, than the term *street*§. But the term street, as in the names of our Watling-street, Ikenilde-street, and Erming-street, may be as likely to be Anglo-Saxon as Roman, and as likely to be British, too, as either. *Ystridæ*, or "the street," is the

* Cæsar, in his *Commentaries*, appears to speak of Britain as part of Gaul; that is, as a Gallic region, divided from continental Gaul only by the sea.

† The Romans, it is true, carefully distinguished their race from the races both of Latians and Italians; with both of which, again, either in ancient or in modern times, foreigners might be apt to confound them. But the history of the Romans is so far this, that they were by origin a small people seated in a large and populous Celtic or Gallic region, and always more or less commingled in language, as well as in sentiment and usage, with the elder possessors of the soil.

‡ Thus, Stratford is Street-ford; Stratton, Stretton, and Streatham, are Street-towns; Streatley is a *ley*, *lea*, or *meadow*, traversed, or by the side of a *street*, or paved or high or public road; and Bolton-le-street and Chester-le-street are towns in similar situations, and abbreviated from "Bolton-on-the-street," or *Sur-le-street* in our Norman phraseology. "The very term 'on the street,'" says a zealous topographical antiquary, "implies Romanity;" and again, "here are two villages of the name of *Stretton*, which carry with them evident Roman etymology.

§ Yet *way*, is perhaps as likely to have come immediately to ourselves from the Saxon *weich*, a "road" or "way," as from the Latin *via;* or *weich* may be the Germanized *via;* or both words may perhaps have a common origin.

modern Welsh; *stract*, the Dutch; *straete*, the Saxon; *strasse*, the German; and all these may either be derived from the Latin *strata*, *paved*, or, with the Latin itself, from one Celtic root. Our *lanes*, which are properly of rural topography, are so called from the Anglo-Saxon, German, or Teutonic; while the *courts* and *alleys* of our towns boast of a French or a Norman original,—a distinction as to town and country objects being always observable in our mixed Norman and Anglo-Saxon vocabulary; but it is not readily to be seen what else the Anglo-Saxons could have called our *paved roads* but *streets*. In our Norman-French we have called them *chaussées* (now corrupted into *causeways*, though more early into *causeys*), but in the Anglo-Saxon there seems to be no other term than *street*. But of streets, lanes, and the rest, more hereafter.

That the Britons had passable roads, is directly to be inferred from their possession of wheel-carriages. That they had chariots or cars for war, is indubitable, and it is very likely that they had other wheel-carriages for purposes of peace. Their acquaintance with that great mechanical power, the wheel, and its application to locomotion, not to speak, also, of the horse, which they had tamed, and knew how to harness to their chariots, leads us to infer that the Britons had good roads in greater or less number, and through a greater or smaller part of the country; and, with good roads, we may suppose, that many other appendages of a respectable civilization existed. Sir Richard Hoare, already quoted several times, believes, from tracing several of their towns and villages, in the risings and sinkings of the turf now growing, that these, besides the dwellings of their inhabitants, had always one or more places of Druidical worship, regularly appropriated to each, like our present town and village churches; and he shows us,as disinterred by himself, numerous works of exquisite though singular skill in art, together with costliness in luxury; and from *barrows*, or burial-places, adjacent to the towns and villages which have seemed to him exclusively devoted to the burial of females, he has produced feminine ornaments so elegant and so rich, as to testify strongly to the gallantry, and therefore to the refinement of the opposite sex, by whom they must have been made and bestowed; and to make it incontrovertible that they had a foreign commerce to enrich them, especially with gold,—so that they either imported expensive works of art from foreign shores, or they paid for the production of them at home.

The Britons, in short, were by race and origin, by language, by manners and customs, by arts and by continued eastern intercourse, an eastern people,—a people connected directly and indirectly with the shores of the Mediterranean Sea, and with all the seats of ancient civilization situate inland from those shores: with Egypt, with Syria, and with Carthage,—and all this, ages before the arrival of the Romans.

The early voyages of the Phœnicians from Syria, and of the Carthaginians from Africa, to the south-western parts of Britain, are subjects of well-attested history, especially so far as relates to the ancient exportation of our tin. There is no reason, however, to doubt that this commercial intercourse had its influence in Britain beyond the simple limits of the coasts, and that it introduced (if they needed it) Phœnician, Carthaginian, Egyptian, and other oriental tendencies of language, customs, and manners. It may be questioned, nevertheless, whether the term *sarsen*, to be heard in Somersetshire, is necessarily so purely, or so exclusively Carthaginian, as described by Dr. Stukeley. It may have been a term used in Carthage, and yet native in Britain also, and derived by both from a common eastern source. By the term *sarsen* is understood, in Somersetshire and the south-west of England, what are otherwise called *boulder-stones*, and in some places by a similitude, *grey-wethers*, from looking upon the downs like *sheep*. In Somersetshire, and other places, these rounded masses of rock overlay the turf, which itself often covers nothing but a chalk stratum, which is still the constant wonder of geology! But the term applied to these masses is, according to Stukeley, Carthaginian. But for objects so rude, and so strictly native, the Britons had surely a native term; and may there not be some relation between the

British term "sarsen," a rock or stone, and the *British* term "sarn," a pavement, or paved road, attributed to the British list of terms in the case of "Sarnelin," or "Sarn Helen?" But to return:—

The British war-chariots, almost identical with those of ancient Egypt, of ancient Greece, and of all the ancient countries of the Mediterranean, which by themselves speak so much for the general civilization which they must have accompanied, will be described when we treat expressly of wheel-carriages, but are referred to at present only as they assist our right estimation of the contemporary British roads. In adverting, however, with due respect to those roads, it is not to be understood that we are quite prepared to agree with those who believe the ancient Britons to have carried the road-making for their war-chariots to such an extent of industry and enterprise as to have cut successions of terraces, or of roads, as it were, in steps upon the sides of the hills and mountains, with reference to the contingent movements of their warriors, and scenes of possible affray and battle. These *terraces* are remarked in England and in Scotland; but in avowed deficiency of actual inspection on a large scale, it may yet be pardoned us if we say that we fancy them to pertain rather to geological science than to the history of either roads or warfare. That the Britons did cut terraces, we are quite willing to allow, since we have inspected a series of them now existing, in a fine state of preservation, at Downton, in Wiltshire; but these are so arranged as to remind one of the raised seats of an amphitheatre, with a stage of verdant turf in the centre, probably for the exhibition of gladiatorial feats, than of ways or roads for the passages of chariots and horses. Terraces on a large scale yet exist in the wilds of North America, where, as we repeat, whatever may have been the state of ancient Mexican civilization, wheel-carriages seem never to have been known; yet these American terraces are probably of natural origin, (small, it is true, if the work of nature, and stupendous, if the work of man,) and mark the successive levels of the subsiding ocean, which once covered, perhaps, the entire continent. But, whatever the origin of these American terraces, we may also be permitted to add that regularity and equal heights, as well as the horizontal levels of these terraces, make them objects of continual interest to the traveller, as likewise the uniformity of their numbers, according to the heights of the several hills or mountains. Each terrace is always an embankment of uniform equal height from its own base; but the terraces rise one above another, according to the height of the hill or mountain in question; such that the present level of the waters will allow of the appearance of the given number of terraces (always of equal height among each other), and no more, upon its side. The most general number is three, and this number is seldom exceeded; but upon the higher mountains five may be counted, and upon those of a lower elevation only two, or even only one. The level of the waters and of the basement of the mountains was the same, and the only difference was in the height of the circumjacent mountains, exposed, in consequence, to more or fewer markings from the waters. Thus, if in the sketch below, a mountain rose to the height shown by fig. 1, or to that in fig. 2, it had one or two terraces accordingly; while if it rose to the

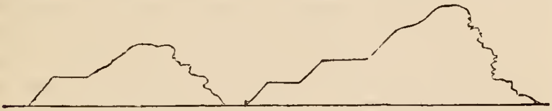


Fig. 1. Fig. 2.

height shown in fig. 3, or to that of fig. 4, it had three terraces, or four, according to the height. Of this kind,

Fig. 3. Fig. 4.

for example, is the beautiful basin in which stands Lake Ontario, in Upper Canada; the lake is surrounded by an amphitheatre of lofty and terraced land (the terraces rising, three in number), each terrace retires further and further from the borders of the lake, and each is as much at a level with the horizon as the calmest part of the waters of the lake. It is from viewing these spectacles, as well as from other considerations, that, with all our esteem for ancient British roads, and for other ancient British works of art, we are led to doubt the origin of the terraced hills in England and Scotland, when this origin is referred to the road-making of the ancient Britons, or to any preparation for the passage of their war-chariots.

That the countries of the eastern hemisphere, enjoying temperate climates, and therefore adapted to the growth of cities and commerce, had roads more or less considerable, and that they improved them from very early dates, is what those who have been properly instructed in general ancient history will have little difficulty in believing. That India, therefore, and even Tartary, China, and Japan, had good and useful roads, and that the same may be said of Persia, Assyria, Syria, Egypt, Greece, Italy, and the countries reaching from the shores of the Mediterranean, to the heart of our own island, will scarcely afford to any reader occasion for surprise; but as to the western hemisphere, which contains America, or the New World, all are so much accustomed to think that region *new*, not only as to European discovery, but as to all human discovery, even to its own population, that to speak of ancient roads, and those of the most elaborate and most perfect workmanship, in any part of the world of Columbus, will startle, at least, some of those who may make acquaintance with them for the first time in these pages.

The roads, and even the establishments for regular posts, in ancient Peru, are topics somewhat familiarized to European knowledge by means of a variety of writings long since given to the world; but the subject of the roads, along with many other works of art and monuments of industry and civilization, in ancient Mexico, has lain in comparative and extraordinary neglect, almost to the day before us. Yet the roads of ancient Mexico are now described to us, from the view of existing remains, in terms which leave behind them all that has ever been said of the roads of ancient Peru, and absolutely allow no claim to superiority even for the stupendous roads of ancient Rome: terms which we may readily credit, if we compare these roads with the remains of Mexican cities, which are now, in like manner, described to us; and with respect to which our single ground of astonishment must arise from the consideration, that, numerous as the population is presumed to have been, numerous and massive as were the edifices of the cities, these roads should have been constructed to resist the wear of the heaviest burdens and traffic in a country, and at a time, when, for all that has yet appeared, there was not the smallest acquaintance with wheel-carriages.

Excepting for the absence of every shadow of evidence that the inhabitants of the mighty city of Paleuca, or of Otulum, or Colucan, had, at any time, the convenience of the humblest description of wheel-carriage, the accounts now given us of the ruins, still to be visited, of that city, might well prepare us for the accompanying accounts of its adjacent roads. Seated upon the banks of the river Otulum, though upon an elevation of five thousand feet above the level of the sea, and overgrown with almost impenetrable forests, in which many of the existing generation of trees are estimated by woodmen at the age of nine hundred years, buildings of hewn stone, more or less uninjured at this time, but surrounded with broken and crumbling stones, columns, and sculptures, cover a space exceeding twenty-four miles in length, and two miles in breadth, at the extremity which was first entered by the explorers, and sixty miles in circumference. An ancient population of three millions of souls, some writers venture to assign to it. We repeat, then, that if the facts just stated were all that remain to be considered, we could easily understand from them how it is that remains or roads, more or less perfect, and more or less extensive, are found in Mexico, and the countries southward; and not only in the immediate vicinity of such ancient cities, but at considerable distances, elaborately constructed, like the Roman Prætorian or military roads, of large squared blocks of stone, and with other distinctions, in the highest degree demonstrative of wealth, industry, and skill. Like our modern rail-roads, and to a degree beyond what was observed by the Romans, these ancient American roads were carried along continued levels; and it is added, that those western artificers constructed—besides these level roads, and besides galleries, tunnels, or subterranean passes, and besides aquaducts—lines of what are called *viaducts*, traversing uneven surfaces, and parapetted along the edges of acclivities, all having marks of division into distances, answering to our mile-stones, and all having here, as in Peru, regular stations for the public posts.

It will be interesting to the reader, if we state the sources of this information. The ruins of the city, called by its Spanish discoverer *El Ciudad del Palenque*, or *Palenca*, or the City of the Desert, or of the wilderness or forest, were discovered in the year 1756, but left wholly unexplored till after a lapse of thirty years; and even from 1786, when it was minutely examined, and described, with the assistance of drawings, by Captain Don Antonio del Rio, under the orders of the Crown of Spain, the whole narrative, and the concomitant drawings, remained buried in the library of the Escurial till within a very recent date. The ruins in question are situated in the province of Ciudad real Chiapa, in the late kingdom of Guatemala, upon the north-eastern coast of that country, and to the south of the port and city of Vera Cruz, and distant 240 miles from Tobasco, and a thousand miles from Mexico, though joined under a general view with our notions of the Mexican empire and history. The city has been called the capital of the kingdom of the Tyendales, the whole of which is said to have been highly populous so lately as the first arrival of the Spaniards in America, and is described by Don Domingo Juarros under the name of *Colhucan;* while by Professor Raffinesque it is called Otulum, from the name of its river, at the distance of a mile and a-half from which the ruins begin to appear. A writer now living in New York, compiling an account of the city from the Spanish authorities, observes that it was ten times the size of what New York was, even in the last year, 1838. It may be added in England, that if a population of three millions can really be assigned with safety to this ancient capital of the Tyendales, the amount surpasses, by considerably more than twice, that of the whole population of modern London and its environs. Ancient cities, however, always covered so much more ground than the modern, or, at least, than the modern European cities, in proportion to the population, that to hazard a statement of the population of this ancient city of America from the mere measurement of its area, or even from the number and size of its buildings, may be thought rash; and what other guides remain to us, in this instance of the city of the Tyendales, it does not appear to be known.

But the ancient roads which in various degrees of preservation are still found, and even ordinarily frequented in various parts of the British Islands, are many of them of a far earlier origin than anything for which we are indebted to the Romans. That roads, in proportion to their workmanship and extent, are testimonials, in all countries, of the civilization of the agent to which they can be referred, is a proposition assumed in these pages; and the question of the real amount of ante-Roman civilization at any time subsisting in, at least, the more favoured parts of our islands, is one, perhaps, not entirely obscure, nor yet entirely without interest in its solution; but we must content ourselves with adverting to the two simple facts; the one that the Britons had roads in greater or less number, and in greater or less perfection before the arrival of the Romans; and that, as to many of those roads, they remain, and are frequented to this day.

But as to the Romans, it is said that, in the roads constructed in Britain by themselves, they usually ran them very much in a line with the ancient British roads, though there was one essential difference between the two systems of road-making, sufficient to ensure frequent separations of their several parts. The Britons, as might be expected of a poor and comparatively artless and unskilful people, wound their roads almost as the country permitted, seeking, for the sake of dryness, and perhaps for greater safety of travel, high and commanding surfaces over which to pass, though lengthening thereby the journey; while the Romans, at ease as to labour and money, and provided with competent artificers, rarely deviated, in submission to natural difficulties, from a straight line, in proceeding from place to place. They raised causeways, as we have seen, through marshes; threw bridges over rivers; removed rocks; lowered hills, or hewed their way through them. Consequently, the British and Roman roads, though they often began and terminated at the same place with each other; yet they incessantly parted and met again through all the interval. But further, as I have before remarked, even when they were the original makers of the roads, either of their earlier territory itself, or of its later increase, it was a common practice with them to carry two roads from the same place of beginning, to the same place of ending; and uniformly to run their military roads distinct, and yet by the side of their public roads; and, from one or all of these causes, it is easy to imagine that, even when the Romans partially adopted the ancient British or native roads*, British and Roman roads were continually crossed and intermixed, as well as sometimes adopted for each other.

Nor were the Romans the only masters of the British soil who took advantage of the ancient British roads in the formation of their own. The early history of the Wans Dyke is, indeed, unsettled; but that this celebrated road affords an example of this practice of adoption, seems in a high degree probable. Its name of Wans Dyke, or Woden's Dyke, or Odin's Dyke, it seems to owe to the Anglo-Saxons; but "the Wans Dyke," says a topographical antiquary, "which has been traced for nearly sixty miles, I believe to be truly the Foss-road, one of the four greater highways originally formed by the Britons." It was by the side also of the Wans Dyke, as we observed before, that the Romans carried their great road from Bath to London.

* Such were the viæ *patriæ*, or *country* roads, so called by the Romans in Britain, and in their other provinces.

The ancient British roads, established before the Roman conquest, are particularly distinguishable, as our readers may have been led to expect, from their not following those straight lines which are the constant characteristic of the Roman roads. Less, or very little assisted by art, the British roads were so made as to include all natural circumstances, in order to an easy formation; and were therefore wound along the ridges or high grounds, which were afforded by the surface; whence they are often denominated *ridge*-ways. They pass along the tops or sides of the chains of hills, or lesser eminences, which lie in the required direction. Along their course they frequently throw out branches, which, after running parallel with the original stem for miles, are again united to it. The track of an ancient British road is distinguished to this day by the mounds which are seen along its sides, and by various banks and hollows which are the marks where villages, towns, and the cultivation and divisions of land into small parcels, have once been. These are often seen at the crossing of two roads, and always upon high ground; for the Britons were intent, or at least more habituated, to dwell in commanding situations, for security against enemies, than to seek the shelter of the valleys against the injuries of weather; and they did not build, it is said, in lower situations, until after the arrival of the Romans.

If the towns and roads of the Britons, as they were found by the Romans, appeared to the latter convenient for themselves, they adopted either or both; but with the addition of their own works of art, and civil and military arrangements. In other cases, they ran new roads in lines parallel with those of the Britons.

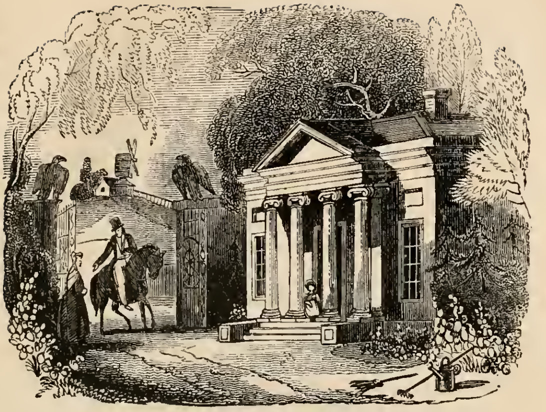
The Anglo-Saxons made roads of stone, and cement or mortar, and of stone and wood; and roads for carriages distinct from bridle-roads, or roads for horses. They called the Roman roads by the name of *military* roads, and the British by that of *country* roads.

One of the marks, in the eyes of the antiquary, of the Roman origin of roads is the peculiar mode of their construction. Their military or prætorian roads were sometimes paved with deep beds of pebbles, and at other times with blocks of free-stone, usually a foot and a-half in thickness. Deep beds of pebbles, found as the ancient foundations of roads, generally indicate their Roman origin. In England, there is a Roman road distinguished in this manner, near Scarborough, and Bridlington, or Burlington Bay.

Another mark in England of the Roman origin of roads is their retention of the Roman name of *street*; a term upon which remarks have been already made in this chapter: in which Roman "streets" in England are of course included the four principal remains of the kind, each departing from London, as from a centre, and in general well-known, as was said, by their respective names of Watling-street, Ikenild-street, Erminage-street, and the Foss-way. In England, however, and in other parts of Britain, as also in many other countries, which were at one time provinces of the Roman empire, there still remain native roads, called by the Romans, *viæ feræ;* which roads were found by the conquerors in the country; and even at this moment, the merits and characteristics of many of them are open to our personal inspection.

Thus far have we discussed the subject of ancient Roman roads in Britain, and of ancient native British roads. From this two-fold subject the transition will be easy to modern British roads, and thence to modern roads in general.

An ancient War-Chariot.



CHAPTER VI.

Remarks on modern Roads.—History of modern Turnpike-roads.—Origin of the Mail.—Undulations and Lines of Roads. Requisites of Good Roads.—Mac Adam.—Telford.—Parliamentary Inquiry.—Gravel-roads.—Macadamizing.—Foundations of Roads.—Telford's Holyhead Road.—Drainage.—Highgate-archway Road.—Repair of Roads.—Continental Roads.—Paved Roads.—Asphalte Roads.—Road-scraper.—Direction-posts.

In coming to the subject of modern roads, we remark all the excellencies which appertain to a garden-walk, and the path of a park, which latter is usually entered at the site of an elegant lodge, are now brought to bear both upon the high and bye-roads of these kingdoms. They are used and enjoyed, not only by royalty and nobility, but even by the humblest of our race.

We have seen in former chapters how sensible the Romans were of the value of roads; so much so, that the government itself took them under its especial protection. That great people spared neither labour nor expense to carry their roads from the centre of their empire to its remotest dependencies. The readier march of their armies was undoubtedly an impelling motive to this; but the easier intercourse of the several parts of this great empire was another advantage, which their wisdom and prudence foresaw. We find, also, on the authority of the Roman historians, that Semiramis, Queen of Assyria, being so fully convinced of the importance of an easy and general intercourse, applied herself to render the roads available throughout the whole extent of her empire.

The transition from ancient Roman and British roads to the roads of the moderns is exceedingly abrupt. On the decline of the Roman empire the roads gradually became neglected; and, during the dark ages, they came to be reckoned among the ruins of a great and mighty people which had passed away. It is now difficult to ascertain what the state of the roads was at different times, from the revival of learning to the end of the last century. The improvement of roads was of necessity slow, because the arts of constructing and directing them were not well understood until very recently. Sweden seems to have been the first kingdom in which the condition of the high-roads at all approached their present state of excellence.

In our own country, from the time of the departure of the Romans to the revolution of 1688, foreign invasions and intestine commotions occupied our ancestors so much, as to make them incapable of improving their means of internal communication. The roads, over which merchandise was carried on horses' backs, seem to have been little better than foot paths, or well-beaten sheep tracts.

In the year 1285, the first act of parliament was passed relating to roads. In 1346 a toll was levied on carts or carriages travelling from Saint Giles'-in-the-Fields to Temple-Bar. In the reign of Henry the Eighth, the first important attempt at improvement was made, by an act, allotting to parishes the care of the roads passing through them, and appointing road-surveyors. The funds were to be obtained from a pound-rate, levied on the land-holders, and assistance in labour was enforced.

One of the most notable circumstances in the history of English roads, is the establishment of a toll, to be paid by the passers along the road, in order to defray a portion or the whole of the expense incurred in keeping the road in repair. This plan was first adopted, we believe, in the year 1663, in the fifteenth year of the reign of Charles II. It did not apply, in the first instance, to England generally, but its operation was confined to the counties of Hertford, Cambridge, and Huntingdon.

The act ordained, that the justices of the peace were to appoint persons to take "sumes of money in the name of Toll or Custome, to bee paid for all such horses, carts, coaches, waggons, droves, and gangs of cattell as shall passe that waye." The tolls were, for a horse one penny, a coach six-pence, a wagon one shilling, a cart eight-pence, a score of sheep or lambs one half-penny, a score of oxen five-pence, a score of hogs two-pence.

It was naturally anticipated that a new law such as this, however much it might conduce to keep the public roads in good order, might meet with some opposition; and severe penalties were incurred by those who slighted the law. If any person refused to pay the toll, the horse, coach, or whatever it might be that was passing along the road, was detained and distrained until the toll was paid.

It would appear that this act was not much relished; for seven years afterwards, in another act relating to highways, a clause was introduced, relative to the interference or obstruction to the taking of toll. It was enacted, that if any person forcibly opposed the detection of cattle, &c., for non-payment of toll, he should be fined forty shillings, and confined in prison until the fine was paid.

At a subsequent period, mobs used to collect, and pull down or destroy the turnpike-gates; the military were often called out to quell the disturbances occasioned by these disagreements; and, at the same time, a penalty of seven years' imprisonment was awarded against those who should continue these unlawful proceedings.

But, notwithstanding, the progress of improvement was very slow. We read of a journey from Glasgow to London, in the year 1739, performed by two persons on horseback; there being no turnpike road till they arrived at Grantham, within 110 miles of London. Up to that point they travelled on a narrow causeway with an unmade soft road on each side of it. They occasionally met with strings of pack-horses, from thirty to forty in a gang,

carrying goods. The leading horse of the troop carried a bell, to warn passengers coming in an opposite direction; and the travellers were then compelled to make way for them, and pass into the road-side, since the causeway did not afford room for both. In 1754 improved turnpike-roads were made; but the opposition attending their first introduction was renewed, and so difficult was it to reconcile the people to such a change, that in the reign of

George the Second, an act was passed, making it felony to destroy a toll-bar.

So inveterate is custom, that the introduction of an improvement which tends to destroy old usages, inconvenient though they be, generally raises a host of alarmists who regard the novelty as a sure proof of the degeneration of our species, and a sign of the decline of the nation. At the introduction of turnpikes, the counties round London petitioned parliament against the extension of turnpike-roads into the more distant counties, lest these latter, having better facility for communicating with the metropolis, might undersell the former, in respect of hay, corn, &c., in the London market; whereby the cultivation of the ground round London would be ruined. The contrary of this has fallen out to be the case: for, although turnpike-roads have ramified throughout the kingdom, the prices of all kinds of meal-produce, and the rents of land have *risen* in the neighbourhood of the metropolis. Again, a writer in the beginning of the seventeenth century speaks of the establishment of stage-coaches "as one of the greatest mischiefs that have happened of late years to the kingdom—mischievous to the public, destructive to trade, and prejudicial to lands." In our chapter on wheel-carriages we will say more on this subject; but we may here mention, that with the improvement of the roads came the improvement of the vehicles which travel over them—especially of mail-coaches and carts engaged in carrying the correspondence of the nation. It will excite surprise at the present day, when we state, that in the middle of the last century the mail-bags were conveyed in small carts, or on horses, and that the post was one of the *slowest and most easily robbed* conveyances in the country. Previous to 1784, the letter-bags were conveyed by post-boys, who were badly paid, and whose characters for integrity were of a very doubtful description. They travelled on bad horses, and were in no way able to defend themselves from the attacks of robbers: indeed, the way-laying of these post-boys for the purpose of robbery was of frequent occurrence, and strong suspicion was often entertained that the boys and the robbers were in league.

About this time a plan was proposed by Mr. Palmer, of the Bath Post-office, for the conveyance of letters with greater speed and safety, as well as economy. He proposed the discontinuance of the horse-post, and the employment of coaches furnished with a well-armed guard to prevent robbery. That the times of the mail-coaches for leaving the country towns should be so regulated as to secure, as far as possible, their simultaneous arrival in London at an early hour every morning: and that all of them should leave London every evening at the same hour. These suggestions met with considerable opposition; but they were eventually adopted, and the first mail-coach on the new plan left London for Bristol on the 2nd of August, 1784. Mail-coaches soon extended to every part of the empire; and while the letters were conveyed more rapidly and safely than under the old system, the coaches themselves offered a more desirable mode of travelling than on horseback.

On the first establishment of roads, the narrow paths made by horses and foot-travellers were adopted and enlarged; and gravel and other materials obtained from the neighbourhood were laid down. This origin is sufficient to account for the windings and rapid slopes, which even the present roads frequently present. We know that the road preferred by the foot-passenger is not always that which is preferable for carriages and horses: the limit of the slopes beyond which it would not be desirable to proceed, is less restricted for foot-travellers than for horses; and less for these again than for loaded vehicles.

The primitive foot-roads or horse-tracks were necessarily tortuous; every obstacle which the ground presented being sufficient to turn the traveller out of his natural direction. Many of these roads were carried over hills, to avoid marshes which are perhaps now drained off or dried up; others deviated from their direct course, in order to be able to communicate with the fords of rivers, which are now passable by means of bridges.

As trade, manufactures, and the wants of the community increased, the roads were gradually made more straight, and the abrupt-ness of their turns and slopes diminished: but as our country nowhere presents those immense plains whose level admits of perfectly horizontal roads to any considerable extent, we still find with all our improvements in levelling, that the roads are varied by gentle slopes and constant undulations. Indeed, perfectly horizontal roads would not in England be preferred; for it is stated by experienced horsemen, that such roads are more fatiguing both to horses and foot-travellers than a road interspersed with gentle undulations: because, say they, the alternations of ascent, descent, and level ground requiring, in turn, the exercise of different muscles, afford rest to those which are for the time least exerted; and thus all the muscles are in succession brought into action*.

Our island is diversified with such an agreeable contrast of hill and dale, as gives a charm to its landscapes; but this feature has not always been favourable to the construction of good roads. At the time of their formation, care has not always been taken, in carrying them over hilly countries, to select the least elevated sites, so as to render the highest point of ascent conveniently low. In many cases this might easily have been done, by leading the line of road through valleys, or along the brows of hills. But, for some years past, our engineers have been engaged in diminishing the too rapid slopes of the old roads, and in endeavouring to preserve the same degree of slope along the whole length of ascent, so that the summits of elevations are frequently reduced by cutting, and the materials thus removed are usually employed in raising the lower part of the road. It has been calculated that very few of these slopes should exceed two degrees of inclination; and Mr. Telford has adopted this proportion as the basis of his improvements on the road which passes through

* Mr. Stephenson, however, does not agree in the opinion that an undulating road is easier for the horses than a level one. He asked the opinion of Dr. John Barclay, a comparative anatomist, on the subject of the anatomy of the horse, with reference to this question. His opinion was hostile to the idea; and he said that, if the horse were allowed to consult his own ease, he would quite disregard Hogarth's "Line of Beauty."

Wales and the Isle of Anglesea. The ascents of this road were, at one time so great as to vary from $\frac{1}{12}$ to $\frac{1}{7}$ per unit of horizontal length or distance. In proportion as these ascents were fatiguing, the descents were dangerous, particularly for swift travelling vehicles.

We have stated that in this country perfectly horizontal roads are not practicable, and that they would not be preferred; so that the perfectly straight roads of the old Romans would not suit the English taste. But so long as the windings of a road do not form any very considerable angles with its direct course, the straight road is very little shorter than the winding road; and the latter costs but little more for its construction and support; and the transports which are made upon it require only a little addition of time and strength. "These little turnings," says Dupin, (whose agreeable and valuable work on our country has greatly assisted us in the present chapter,) "these little turnings produce an agreeable effect with reference to the surrounding scenery; so that the road becomes an ornament to the country, and the country itself is exhibited to the best advantage to the eye of the traveller, who, by the course of the road, is led to those points which command the most pleasing prospects. Why should we neglect this mode of enhancing the enjoyment of the beauties of nature, when in our cities we expend such considerable sums in futile amusements, and in pleasures less pure and positive?" It may also be added that by giving a gentle winding direction to the roads, the traveller is relieved from the fatiguing and tiresome prospect of a course which seems interminable. I have frequently so experienced —

The principles upon which roads ought to be constructed, have been recently, and to a certain extent, developed through the skill and attention of modern engineers. The fine roads which have been formed within the last twenty years, and which continue, with only slight occasional repairs, to fulfil the conditions required of a perfect road, ought to be taken as models; and no variations allowed, except on strictly scientific grounds. The conditions of a good road are thus plainly defined by Mr.

Mac Adam: "A road ought to be considered as an artificial flooring, forming a strong, smooth, solid surface, at once capable of carrying great weights, and over which carriages may pass without meeting any impediment."

Hardness and smoothness, then, are the great requisites of a good road. One of the greatest impediments to travelling on a soft road is this: when a wheel presses down soft soil, a ridge is formed, not only at the *sides*, but in *front* of the wheel, and this front ridge exercises an enormous effect. "If a coach or wagon, weighing 60 cwt.," says a practical modern writer, "supported by wheels four feet in diameter, formed a new rut an inch deep in a smooth road, the length of the part immersed being about fourteen inches, the horizontal resistance from the raised ridge in front would be about $\frac{1}{17}$th of the weight, upon the lowest supposition that is at all admissible, and more probably about $\frac{1}{9}$th, or from 6 to 7 cwt. at least; and if the rut were two inches deep, the resistance would be half as much more. An increase in the diameter of the wheel obviously reduces this horizontal resistance." In the formation of roads the variations are principally with respect to their width.

The limits of by-roads have been prescribed by law as follows:—foot-paths, six feet and a-half wide; horse-roads, eight feet; carriage-roads, twenty feet. For turnpike-roads, at the approach to populous towns, the prescribed width is sixty feet; but this width is by no means always obtained. Before the grand improvements in road-making, which were introduced chiefly by Telford and Mac Adam, the width of the roads, at a short distance from many of our principal towns, was only eighteen feet, and sometimes not more than thirteen feet; so that the meeting of rapidly-moving vehicles, and the passage of numerous flocks and herds, occasioned great delay, and frequently gave rise to serious accidents. To the remedy of these inconveniences, the attention of the road-trustees, as also of Parliament, was for a long time earnestly directed; and the public roads are now, probably in every part of the kingdom, sufficiently spacious to afford facility to conveyances pertaining to the most extensive trade.

On the subject of the *width* of roads, M. Dupin introduces an elegant remark: "It is absurd," says he, "to allow roads in the least-frequented districts, to preserve the same dimensions as those which lead to the capital and great towns. Many persons, however, regard this excessive width of the public roads as a sign, and almost as an emblem, of moral and political greatness. They judge of empires according to the amplitude of these superb and expensive zones, as the vulgar judge of great noblemen, according to the breadth and glitter of the lace which adorns the liveries of their servants. Let us hope that in due time the progress of reason will banish these absurd opinions."

A great deal of discussion has taken place on the extent to which roads should be elevated in the centre, or depressed towards the sides, in order to allow water to drain off. One great fault of badly-made roads is the formation of *ruts*, one by each wheel, and another by the horses' feet. These ruts retain much water, keep the road in a constant state of ruin, and allow no dry path for foot-passengers. To remedy this, some roads have been made to slope at one of their sides only, so as to leave the higher side dry, and passable to foot-passengers. Ditches also are dug along the road, which allow the water to drain off. The great convexity of the old roads caused many serious accidents from the upsetting of carriages, and, taking advantage of the lessons of experience, our modern road-makers have considerably diminished the convexity of their structures. Indeed, Mr. Mac Adam says, "I consider a road should be as flat as possible with regard to allowing the water to run off at all, because a carriage ought to stand upright in travelling. I have generally made roads three inches higher in the centre than at the sides, when they are eighteen feet wide; if the road be smooth and well made, the water will run off very easily in such a slope." And again, he says: "When a road is made flat, people will not follow the middle of it, as they do, when it is made extremely convex. In very convex roads, travellers generally follow the track in the middle, which is the only place where a carriage can stand upright, by which means three furrows are made by the horses and the wheels, and the water continually stands there; and I think that more water actually stands upon a very convex road than on one which is reasonably flat." And in Mr. Telford's celebrated road, he has given for the transversal inclination no more than that which is produced by a rise of eight inches in a width of thirty-three feet.

One great cause of the superiority of British roads over the roads of other countries, consists in the abundance of road-making materials which this country produces. The ground, too, over which the roads are traced, is, in most parts, naturally very firm, from being composed of a mixture of sand, gravel, and flint, which enables the water to filter easily through it, and thus leaves the road dry almost directly after rain. "The climate of England, too, though habitually damp, is not subject to those heavy torrents of rain which occasion such a rapid destruction of the roads in more southern countries. These causes, however, are not sufficient to account for the excellence of the roads in Great Britain; for in many parts of the north of England, and in Wales, where heavy rains are frequent, and where the waters run in rapid torrents, public roads have been constructed of a perfectly good quality. Indeed, even on marshy and clayey soils, roads have been formed remarkable for their solidity, durability, and dryness."—Dupin.

The materials employed in road-making differ according to the mineral productions of the counties through which the roads pass. For example, in Essex, Sussex, Shropshire, and Staffordshire, flints mixed with sand are employed. In Somersetshire, Gloucestershire, and Wiltshire, limestone is commonly used. This latter substance offers but little resistance, and its durability is therefore small; but when properly prepared and laid down, it forms a compact road, and binds more readily than any other road-making material.

In the report of the Parliamentary Committee on the highways of the kingdom, we find, in the minutes of the evidence taken, some curious and valuable information offered by engineers, coach-proprietors, and persons concerned in the making and using of roads. Although several years have elapsed since the date of this inquiry, yet the subject is still new and applicable. The "experimental pavements" in Oxford-street, which, at the time we write, are being tested,—the state of our roads in inclement weather, and the slowness and difficulty of the passage of vehicles over them,—the conflicting opinions which still exist among the best road-makers,—all this proves that we have hitherto by no means arrived at perfection in the art of road-making. The following information will, therefore, be acceptable to such of our readers as desire to know the qualifications of a good road, and the tests whereby to distinguish a bad one; what materials are good and what are worthless; how good materials may be made bad, and bad materials be converted to useful purposes. These, and many other connecting subjects, will usefully employ our time and attention in the present chapter, since one of the very best modes of ensuring improvement, is to convince every member of the community of its necessity and advantage.

A few years ago, it was stated on good authority, as a remarkable fact, that the great high roads leading into London, and which from their beauty were the admiration of foreigners, were formed of the worst materials: viz., a kind of argillaceous gravel and small flinty nodules, which, from their spherical form, were prevented from uniting like broken stones, whose flat surfaces come in contact, and produce, by the pressure of the wheels, a compact mass, which becomes daily more solid. But there are some absurd laws and regulations with respect to water-carriage, detailed by Mr. Mac Adam in his evidence, which prevent the transport of good road-materials to London by the Thames, and the numerous canals which converge to the capital.

Roads formed with gravel mixed with earth are always bad. The rain converts the earth into a mass of thick heavy mud; but, if care be taken to wash the gravel thoroughly, and to break the stones, a good road can be formed: the Reading road is made of very inferior gravel, but by adopting these precautions it is perfectly smooth, firm, and level. This shows us that bad materials, when science and skill are employed in their application, are better than good materials in the absence of both; for we find that in Scotland, where the materials for road-making are everywhere abundant and cheap, many of the roads are rough, loose, and extremely expensive in their construction, because the materials are unskilfully used.

The traveller, inexperienced in road-making, while being whirled over the roads in the vicinity of London, admiring them for their apparent smoothness, absence of ruts and jolting, is sometimes inclined to thank the kind fates which made him an Englishman, and furnished his country with such superb roads. But what say the coach-proprietors and persons who are well entitled to a professional opinion? They say that the much admired metropolitan roads are so soft and yielding, and the difficulty of transit over them so great, that, in order to proceed as rapidly as they are accustomed to do at a greater distance from the capital, their coaches must be drawn by horses of very superior strength; and that the fatigue endured by these poor animals is so excessive, that they are rendered useless in so short a time as three years! "The foreigner," says Dupin, "justly admires the beauty of the horses attached to the public vehicles in the neighbourhood of London; but he is far from suspecting that the choice of these animals is occasioned by the very defects of the road which is so magnificent in appearance, and so pleasant to the traveller."

Let us now inquire into the plans suggested by Mr. Mac Adam, and so extensively adopted for repairing an old and defective road, or for making a new one.

No new materials, he observes, are to be brought upon a road, unless in the absence of a quantity of clean stone equal to a thickness of ten inches. The old stone material is to be taken up*, carried to the road-side and broken, so that no piece may exceed six ounces in weight: the road is then to be laid as flat as possible, leaving a fall

* Mr. Mac Adam calls this operation, "lifting the road."

of three inches from the middle to the sides, when the width of the road is thirty feet.

In order to regulate the size and weight of the stones, the former not exceeding one inch longitudinally, and the latter not more than six ounces, the people who break the stones are furnished with sieves made of iron, with circular holes: every piece of stone that will not pass through this sieve is laid aside. The overseers of the road are furnished with a balance and a weight, for weighing two or three of the largest fragments of each heap of broken stones, to ascertain that none are too heavy.

When all the great stones are thus broken, the surface of the intended road is to be smoothed with a rake, and the broken stone is to be spread over it carefully: this operation requires attention, since the future quality of the road will depend on the mode in which it is done. The stone must not be laid on in shovels full, but scattered over the surface, one shovel-full following another, and being spread over a great space.

The proper mode of breaking stones, both for effect and economy, is in a sitting posture. This work can be done by women, boys, and old men past hard labour.

Breaking Stones.

In some cases it would be imprudent to *lift* the road, even if the materials be too abundant; for example, the road between Bath and Cirencester was made of large stones, but so soft, that they would have fallen into sand if removed. Mr. Mac Adam merely had the higher parts cut down, sifted, and replaced; and thus the surface kept smooth, while those materials lasted. They were subsequently replaced by stone of a better quality, properly prepared. At Egham it was necessary to remove the whole road, in order to separate the small portion of valuable material from the mass of soft matter in which it was enveloped; and this was removed at a great expense, before a good road could be made. A durable road cannot be made with freestone; but, if judiciously laid down, it forms a good surface while it lasts.

When new stone is to be placed on a road already consolidated, the hardened stone is to be loosened with a pick, to enable the new materials to unite with the old.

A new road requires constant raking until the materials are consolidated; so that the tracks made by the wheels must be filled up, so long as any loose materials remain on the road.

No "binding" material, as it is called, is ever to be employed, such as earth, clay, chalk, or any substance at all that will imbibe water. It is necessary that our readers should be aware that water, in the act of freezing, expands with amazing force. Major Williams filled a very stout iron bomb-shell with water, and closed it tight, by means of an iron screw: on exposing this apparatus to a frosty air, the enclosed water froze, and by its expansion burst the bomb-shell. Now, when water soaks into a road, and becomes frozen, it lifts up and displaces the whole structure: this is called, the "breaking up of roads by frost;" and the mischievous effect is particularly remarkable in the subsequent thaw: the roads then often become im passable. This, then, is one great reason why Mr. Mac Adam, in the formation of his roads, discarded every substance likely to imbibe water: he found that good stone, well broken, will combine, by its own roughness and angles, into a solid compact body, having a smooth surface, not affected by the vicissitudes of weather, nor disfigured by the action of wheels, which, as they pass over it without a jolt, (or, as the coachmen say, "the road runs true,") will, consequently, do the road little or no injury.

The tools employed by Mr. Mac Adam were, first, strong picks, but short from the handle to the points: second, small hammers weighing about a pound, with a face the size of a shilling, well steeled, and with a short handle: third, rakes, with wooden heads, ten inches in length, with long and strong iron teeth, about two inches and a-half long, for raking out the large stones when the road is being "lifted," and for smoothing it when completed and while consolidating: fourth, light broad-mouthed shovels, to spread the broken stones.

The whole expense of preparing and newly forming a rough road to the depth of four inches, is about a penny or twopence per square yard; the expense varying with the quantity of stones to be broken. A ton of stones may, if properly managed, be broken for a shilling, and sometimes for less; often including the value of the stone itself. A great advantage attending Mr. Mac Adam's mode of road-making, is the great diminution of horse-labour: human labour being substituted, whereby a valuable source of employment is opened to the poorer classes, when, in the absence of agricultural and other pursuits, work is otherwise so difficult to be provided for them, while the parish is, nevertheless, responsible for their support. At one time, in the vicinity of Bristol, for example, one-fourth of the whole expense of road-making, was incurred for men's labour, and three-fourths for that of horses; but, by the introduction of Mac Adam's system, the proportions were reversed, one-fourth only being incurred for horse-labour, and the rest for the labour of men, women, and children.

Let us now speak of the *foundations* of roads, about which a singular opposition in opinion has been distinctly stated by Mr. Mac Adam, and by Mr. Telford. The former gentleman says, that in order to construct or repair a road, a layer of solid materials, ten inches thick, is sufficient, and that this will bear all sorts of loads, whether the soil below, (which we call the *foundation*,) be firm or not. He even prefers a soil consisting of a mixture of hard and soft materials, to one that is quite hard. He states, that on the former, the roads are more durable; because they rest on an elastic bed, which yields to very heavy pressure, and deadens violent shocks; probably, on the same principle, and for the same reason, that an anvil mounted on a block of wood, will last longer than if mounted on stone.

As an example of this singular and apparently paradoxical statement, the details of two roads, thus constructed, were given to the Committee of the House of Commons. The road from Bridgewater to Cross, is partly made over a moveable morass; so that, when travelling along it in a coach, the water may be seen quivering in the ditches on each side. After a slight frost, the quivering of the water, occasioned by the motion of the wheel-carriages, is such as to break the ice formed on its surface. Adjoining this marshy road is another, formed on a foundation of calcareous stone. The expense of keeping these two roads in repair, is in the proportion of five to seven; though that portion of road which is carried over the hard soil lies higher than the other.

In making roads on a marshy foundation, Mr. Mac Adam did not employ larger fragments of stone than usual. He has shown that the stone will not sink into the soft soil, because, he says, the elements composing the road unite together, and form a large, compact, and solid mass, which has no tendency to sink in one part more than in another. The thickness of the bed of materials, which he would then propose to lay down, would vary only from seven to ten inches; and he states that five tons of broken stones laid down in this way, make as good a road as seven tons of stones laid on a very hard foundation.

This theory is plausible, but it is also specious: experience has shown it to be erroneous. Let us now see Mr. Telford's opinions and practice on this subject, as stated by Mr. Provis, who assisted as an engineer under Mr. Telford in the great Holyhead road. He says, "the pitching or paving the bottom of a road is a subject which has often been discussed, and though generally approved of by scientific men, has met with some decided opponents. On the old part of the Shrewsbury and Holyhead road which extends from Gobowen to Oswestry, as well as in some other places, the foundation of the road had been paved, but in an irregular and promiscuous manner, some of the stones standing near a foot above others, and in some places holes were left without any stones; upon this a coat of gravel had been laid, and necessarily of very unequal thickness, some of the points of the stones being scarcely covered. This road having afterwards been much neglected, the upper gravel, where thin, was worn quite away, or else forced from its bed by being in so thin a coat that it could not bind, and the road's surface was thereby made a continued succession of hard lumps and hollows, with water standing in every hole after a shower, and no means of getting off, except by soaking through the road. Any stranger, on passing over such a road, would condemn the principle on which it was made. But here seems to be the great error,—that the principle is condemned instead of the abuse of it. When the paving is put down carefully by hand, of equal or regular height, with no large smooth-faced stones for the upper stratum to slide upon, and the whole pinned so that no stone can move, I have no hesitation in saying that in many cases it is highly beneficial, and in none detrimental. Whenever the natural soil is clay, or retentive of water, the pavement acts as an underdrain to carry off any water that may pass through the surface of the road. The component stones of the pavement, having broader bases to stand upon than those that are broken small, are not so liable to be pressed into the earth below, particularly where the soil is soft. The expense of setting this pavement is less than one-fourth of that of breaking an equal depth of stones to the size generally used for upper coating; and therefore in point of economy, it has also a material advantage. Mr. Telford, in all cases, recommends this mode of paving, and the opinion of a man of such experience cannot be treated slightly. He has made more miles of road than any engineer in the kingdom; and having myself studied for nearly fifteen years in his school, and made a considerable extent of road under his direction, I may venture to say that his practice is not unsupported by experience. I should not have said so much on this subject, but from the circumstance of other road-improvers having asserted that paving is useless; and I think that assertions on one side, should be met with firmness on the other, whenever an important principle is attacked, the correctness of which can be established by reasoning and by facts."

Mr. Telford's celebrated Holyhead road was constructed upon a well-digested plan of his own. In his specification, he says, "The road is to be 30 feet wide, exclusive of footpaths, with a fall of six inches from the centre to the side channels." The foundation, if of a wet or spongy texture, is to be well *rammed* with chips of stone; and in some situations it is advisable to have a stratum of hand-laid stones of from five to seven inches deep, with their broadest ends downwards, and the whole made compact. The uniformly broken stones, (technically called *metal*,) must be laid upon this so as to form a compact solid body. To make the stones of uniform size, a ring, two and a half inches in diameter, is provided, through which each stone will pass. No binding material or gravel is to be used on this body of metal; because the sides of the stones soon wedge together, and form an even surface. Green-stone is preferred for road-metal, as being less friable even than granite, when broken small. In the absence of better materials, sand-stone, lime-stone, and chalk, may be used; and where coal is abundant, the sandstone can be reduced to a vitreous mass in kilns, erected by the road-side; but all such road-metal is bad, and is not used except in necessitous cases. But in some parts of Wales, scoriæ, procured from the furnaces of iron-foundries, &c., and ashes obtained from the stoves of steam-engines, are used instead of fragments of stone, and form durable roads. In the absence of road-making materials, clay, baked like brick, and then broken into fragments has been employed; but this practice must altogether depend upon the value of fuel in the districts where it is adopted.

In places remote from quarries of hard stone, Mr. Telford introduced a plan, by which gravel may be advantageously adopted, and populous roads rendered solid and durable. In the following table we have a vertical section of such a gravel-road, 30 feet wide, showing the disposition of the layers, and the fractions of the upper layers.

Thickness of the layers.	Siftings of Gravel.	Small Gravel Stones.	Large Gravel Stones broken.	Large Gravel Stones broken.	Small Gravel Stones.	Siftings of Gravel.
3 inches	3 feet	4 feet	8 feet	8 feet	4 feet	3 feet
3 inches	Layer of Lime.					
6 inches	Layer of Gravel.					
6 inches	Layer of Lime.					
	Clay, serving as a foundation for the Road.					

One department in the art of road-making, and that which requires the exercise of great judgment and skill, is *drainage*. How often do we see, even at the present day, many of our high roads so constructed as to form excellent *gutters* to the adjacent fields! If good roads be at all desired, especially in places subject to inundations and great moisture, the ground over which the road is laid must be raised: deep ditches must be dug on both sides, and parallel with the road. Into these ditches there must branch out, at intervals, subterraneous drains. These latter have been formed by digging to the depth of from four to eight feet, and placing a layer of fagots of brambles, two feet thick, at the bottom of the hollow; above this is laid stubble or turf, and the whole is covered with a layer of earth. The width of these aqueducts is nearly three feet, and they endure for more than twenty years. It must also be observed that roads ought to be above the level of the adjacent fields; otherwise they are likely to be wet and muddy, always out of repair, and difficult of passage both to man and beast.

It appears then from all that has been said, that a dry and solid foundation is necessary to the construction of a good road; and so far Mr. Mac Adam's practice seems erroneous. We will therefore conclude the subject of road-making with the opinions of Mr. Macneill, as expressed by himself.

"Well-made roads," says he, "formed of clean hard broken stone placed on a solid foundation, are very little affected by atmospheric changes; weak roads, or those which are imperfectly formed with gravel, flint, or round pebbles, without a bottoming, or foundation of stone pavement or concrete, are, on the contrary, much affected by changes of the weather. In the formation of such roads, and before they become bound or firm, a considerable portion of the sub-soil mixes with the stone or gravel, in consequence of the necessity of putting the gravel on in thin layers: this mixture of earth or clay, in dry warm seasons, expands by the heat, and makes the road loose and open; the consequence is that the stones are thrown out, and many of them are crushed, and ground into dust, producing considerable wear and diminution of the materials. In wet weather, also, the clay or earth mixed with the stones absorbs moisture, becomes soft, and allows the stones to move, and rub against each other, when acted upon by the feet of horses, or wheels of carriages. This attrition of the stones against each other wears them out surprisingly fast, and produces large quantities of mud, which tends to keep the road damp, and by that means increases the injury."

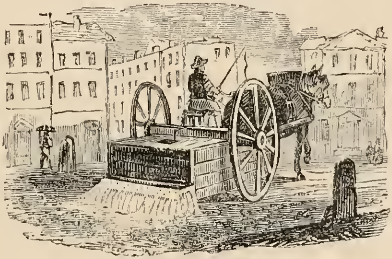
In the formation of the Highgate Archway-road, no stones could be obtained for making a foundation of pavement; in consequence of which a composition of Roman cement and gravel was employed by Mr. Macneill, and succeeded admirably. There were four longitudinal drains, and also secondary drains running from the former to the side channel drains, and those again to drains outside the footpaths, covered with brick. On the prepared centre of six yards' breadth, after being properly levelled, the cement was laid, after mixing it first in a box with water, gravel, and sand, in certain proportions. In fifteen minutes this became hard; in about four minutes after being laid, a triangular piece of wood, sheeted with iron, was indented into it, so as to leave a track or channel for the stones to lie and fasten in. This indent had an inclination or fall from the centre to the side of the road of three inches, which allowed the water that percolated through the broken stones to run off the cemented mass into the drains. This road has not been injured by frost, nor by the working of carriages over it.

It appears that the destruction of a road is due more to the feet of horses, than to the wheels of vehicles. Mr. Gordon has calculated that a set of tires would run 3000 miles in good weather, and 2700 miles in average weather; but that a set of horses' shoes would bear only 200 miles of travel.

In coming now to speak of the *repair* of roads, we may observe that the same general principles which regulate their construction apply also to their preservation. The materials of the road, when pulverized by the action of carriage-wheels, and converted by wet into mud, are scraped from the middle of the road, and heaped up along the sides, to be carried away in carts to the neighbouring fields, where they act as a useful manure. New materials are not laid down on the road, nor are the ruts which may begin to appear filled up, until after the dust and mud have been removed. The mending of the road, too, should take place immediately after moving the mud, and while the ground is still wet. It is necessary also to adopt special plans for keeping the roads, as far as possible, dry; especially in such a climate as ours, where so much dampness prevails, and the heat of the sun is seldom powerful. Trees and shrubs must not be planted within 15 feet of the centre of the road. If any such plantation exist, and the trees be not cut down within ten days after the surveyor has given notice to that effect to the owner of the ground, the owner is subject to a penalty; and, if necessary, he can be compelled to clear the public thoroughfare. So also with respect to hedges, the law requires them to be cut so as not to occasion too much shade, thereby preventing the free circulation of air for drying the ground in wet weather, and the sweeping off of the dust in dry weather.

When a road is formed of good materials, an occasional washing by heavy rains, or by artificial means, is considered useful, not only as affording comfort to passengers, and facility for driving, but as tending to preserve the road. When the road is thoroughly washed, the mud is carried off in winter, and the dust in summer; the action of the wheels too is less injurious to the wheels themselves and also to the road; and, at the expiration of a few hours, even after a succession of rain, the road may be found firm and dry.

The following cut will remind our readers of the irrigation of roads in summer for the purpose of laying the dust.



Watering Cart.

We come now to notice the *paved* roads of our cities and towns, in contradistinction to the turnpike roads, which have already occupied our attention.

"On visiting the squares and streets in the great towns of England," says the illustrious foreigner whom we have already quoted, "the traveller is struck with the cleanliness, propriety, and arrangement, which they exhibit. . . . . In the best parts of the principal towns in England, the fronts of the houses are separated from the street by an area, surrounded by an iron railing; and this railing is separated from the horse-road by a broad foot-pavement. Thus the walls of the houses are not disfigured by dirt and splashes, as is the case in the towns of France. . . . . In the most modern parts of London, the extensive proportions of the streets present the imposing appearance of a great capital. In Oxford-street, which is more than a mile in length, five carriages may drive abreast, between two broad foot-pavements. These dimensions are indispensable in the most commercial city in the world."

We have already stated that gravel roads, though fine in appearance, are very fatiguing to the horses. It is stated also that, taking the average of every day in the year, horses will go through more work, with the same extent of fatigue, on a *paved* road than on a gravel road, if the draught be considerable. This assertion is well supported by Mr. Edgeworth, who has examined the matter experimentally, and he declares himself decidedly in favour of *paved roads* for all places where there is active traffic.

The horse-roads in London, when paved, are made of granite, brought from Scotland and Cornwall; and the flag-stones for foot-pavements are brought from the peninsula of Portland, on the coast of Dorsetshire. The conveyance of these materials is a considerable branch of mercantile navigation.

Paving.

When the system of Mac Adam was brought into operation a few years ago, most of the granite pavement of the principal thoroughfares of London was taken up and broken, and the roads Macadamized; but experience has shown that the alternate dust and mud on these roads are excessively noxious in crowded thoroughfares, where dust and mud are generated by ceaseless traffic, however well Mac Adam's plan may succeed for turnpike-roads. A variety of stone paving, and even cast-iron plates, has been suggested, and partially adopted.

Two kinds of pavement are chiefly adopted in the capitals of Great Britain and Ireland; the one is termed the *ruble* causeway, and the other the *aisler* causeway. In the ruble form, the stones are slightly dressed with a hammer; in the aisler form, the stones are nearly of determinate dimensions, varying from five to seven inches in thickness, from eight to twelve in length, and about a foot in breadth. A good specimen of the aisler causeway is to be seen in the Commercial-road, leading from Whitechapel to the India Docks, at Blackwall and Poplar. This road is seventy feet wide, and two miles long. The footpaths are laid with Yorkshire flags, and the roadway with granite. The tramway consists of large blocks of stone, eighteen inches wide by twelve inches deep, and from two-and-a-half to ten feet long; these are placed in rows, four feet apart, on a hard bottom of gravel, or on a concrete foundation; their ends are firmly jointed together, so as to prevent any kind of movement. As an example of the value of this road, it is stated that a loaded wagon, weighing ten tons, was drawn by one horse from the West India Docks, a distance of two miles, with a rise in the road of 1 in 274, at the rate of nearly four miles an hour. Mr. James Walker is the engineer of this fine work.

In English towns generally, the carriage-roads, if paved, are covered with blocks of stone, more or less resembling cubes; while the footpaths are covered with broad thin flag-stones. In Florence, the whole breadth of the streets is paved with flag-stones, placed diagonally; and in Naples the surfaces are nearly as smooth. In both these cases, it is necessary to roughen the stones frequently with chisels, wherever there is a hill or bridge, in order to prevent the horse from slipping; but in both cities the horses, from habit, are sufficiently sure-footed, even when running with some rapidity. In Milan, both kinds of pavement are mixed together in the same street; the smooth kind in two double lines for the wheels of carriages coming and going, and the rougher in the intermediate parts, for the feet of the horses.

We fear to add any more descriptions of stone pavements to our chapter, which already contains, perhaps, too much of what the general reader may designate dry detail; but we cannot omit the mention of an interesting substance which has been lately introduced into the metropolis as a covering to the surface of its populous ways. We allude to *Asphalte*, or *Asphaltic Cement*, the history of which is briefly as follows:—

About the year 1712, a Greek, named Eirinis, discovered in the valley of Travers, in Prussian Neufchatel, a bed of asphaltic rock, which he describes as being composed of a mineral substance, gelatinous, and more adhesive than pitch, solid, and well adapted as a cement for buildings, &c., preserving timber from dry rot and from worms, and enabling it to resist the action of time and the vicissitudes of weather. He tried it experimentally, and found that when melted, and mixed with a small portion of pitch, and spread on the substance to be preserved, its success was complete.

No notice, however, seems to have been taken of the Greek's proposal till the year 1838, when the Count de Sassenay became proprietor of the mines of the valley of Travers. The Count established a company for the working of asphalte, whence England receives its supply.

The Count has published an interesting little work on the subject of the asphalte cement. He distinguishes several varieties of asphalte, and states the real cement to consist of bitumen combined with calcareous matter. This substance is obtained by simple mining operations. Small cavities are made in the rock, which are filled with gunpowder, and thus large masses are detached by blasting. The powder has most effect in cold weather, when the rock is harder. The cement is prepared thus:—Ninety-four parts, by weight, of the asphaltic stone are pulverized, mixed with six parts of bitumen, and melted in large boilers; the mass is then poured off and formed into large cakes, which constitute the cement. In spreading this substance over roads, &c., it is remelted and mixed with fine sand, which gives it more stability, and a degree of roughness which prevents the feet from slipping.

This cement is valuable, not only on account of the smooth and level surface which it produces on the road, but also on account of its extraordinary durability. More than a hundred years ago, a staircase was coated with the cement by Eirinis, and it has not yet given any signs of being worn down; while a stone staircase, constructed at the same time, and in the same house, is completely hollowed out by footsteps. It has been extensively adopted in the public buildings of France; it is easily washed, and affords a protection against damp. Rats and mice also are said to have disappeared in places where the cement is used. It has also been spread over the road of a much-frequented bridge at Paris; and though exposed to all the changes of weather, and the tread of thirty thousand people daily, it exhibits no signs of decay. It has also been adopted in several parts of London, by way of experiment, and we believe it to be successful, especially on the Ferry-road, Mill-wall, Poplar, and on the Vauxhall-road. There are, however, many imitations of this cement now being imposed upon the public, but they are all unsuccessful, and will not bear comparison with the real article, as obtained from Prussia.

We cannot, of course, verify the statements, which we have obtained chiefly from Count de Sassenay's work, but it appears, from other sources of information, that most of the praise bestowed on the asphaltic cement is really its due.

The English are particularly distinguished for the pains they bestow on the cleanliness of their roads. The humble but useful occupations of the scavenger and road-scraper we need not here describe; but an ingenious instrument, lately introduced by its inventor, Mr. Bourne, deserves notice. This machine is formed of a series of scrapers fastened to wooden rods, acting on a common axis, yet rising or falling singly and independently of each other, so as to meet the inequalities of the road's surface. They are all inserted into a frame, the lower part of which passes on the scrapers, the upper part being the handle; the machine is then fixed on wheels, and the mode of using it is by hand. The workman commences at a given place by elevating the handle, which sinks the scrapers, and he drags the machine across the road at right angles to the line of draught; when he has dragged the mud to the opposite side, he depresses the handle, and the scrapers rising, deposit their gatherings. The independent action of each scraper enables the whole to enter and cleanse out any holes or depressions of the surface, or to get over any hard projection, and to adapt itself generally to any state of road, or to any kind of surface.

Before concluding this chapter, we should remark that, in England, not only are good roads made for the traffic of horses and carriages, which roads are kept *dry*, and also *moist*, as the season may require, but the *footpaths* for pedestrians are more numerous and commodious than in any other country: yet, for all this, the English are said to walk on foot less than the people of any other nation. Sign-posts are also numerous, for the ready information of every traveller, whether on foot or on horseback, as to his route, and the readiest path whereby to arrive at his destination.

But since roads, admirable and useful as they are, would have their usefulness greatly curtailed were they confined to land only, especially in a country like our own, abounding in rivers and artificial streams of water of so many kinds and dimensions, we come now to consider a more difficult and elaborate description of road, which is carried over the surface of water, and serves the useful purpose of connecting ordinary roads together. This, however, is an extensive subject, to which we must devote the next two chapters.

Direction-Post.

Stepping-stones.

CHAPTER VII.

Importance of Bridges. — Oberlin's Pont de Charité. — The Arch.—Chinese Bridges.—Roman Bridges.—Modern Bridges. The Brethren of the Bridge.—Croyland Bridge.—History of London Bridge.—Coffer-dams and Caissons. — Other Bridges over the Thames. — Pont y Prydd.

In the memoirs of the virtuous Oberlin, the pastor of a poor protestant flock, in one of the wildest parts of France, viz. Waldbach, in the Ban de la Roche, we find this good man in the early part of his career endeavouring to civilize a rude and superstitious people. He judged rightly in supposing that by bettering their social condition, he should promote their moral, and thereby prepare a way for their spiritual improvement. From the record that is given of him, we select a specimen, as showing not only the value of the arts of life generally, but of bridges in particular, in assisting the great cause of civilization. As the ship of the ocean brings the members of different nations and of different climes in frequent communication, so the bridge enables villages, towns, and cities, which are separated by natural obstacles, to communicate with, and, consequently, to help each other.

It appears that all the roads belonging to the Ban de la Roche were impassable during the greater part of the year; and the only ready mode of communication between this parish and the neighbouring towns, was by *stepping-stones* over the Bruche, a stream which, having its sources in the mountains, falls into the Ill before it reaches Strasburg. It was thirty feet wide at the crossing-place; and in winter, when the stream was swollen, it became impassable. Being thus confined to their own valley, the inhabitants had no means of disposing of their produce in other parts, nor of obtaining those comforts or conveniences of life which they could not of themselves produce. They had been accustomed, in consequence of their limited means of communication, to endure a bare and wretched subsistence; and they had not even the most necessary agricultural implements to aid them in obtaining this. Such was their condition when Oberlin assembled them, and proposed to open a communication with the high road to Strasburg by blasting the rocks, constructing a solid wall to support a road about a mile and a-half in length along the banks of the Bruche, and building a bridge across that river near Rotham.

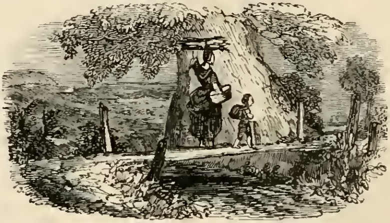
This proposal greatly surprised the peasants; they deemed it utterly impracticable, and shrinking from the idea of so vast a work, they one and all declined it. To their numerous difficulties and objections Oberlin replied by reminding them of their situation: that they were shut up in their own villages three-fourths of the year; that if this road were made *and a bridge thrown across the river*, they would always have a free intercourse with the neighbouring district, they would always have a ready market for their produce. They might supply their most urgent wants, and bring comforts home to their families which their own sterile valley * did not afford; and he concluded by saying, "Let those who see the importance of my proposal come and work with me." With that, he shouldered a pickaxe, and, assisted by a faithful servant, began the work. The reasonableness of Oberlin's speech and his admirable example produced such an effect on the minds of the peasants, that they ran simultaneously for their tools and joined their pastor, who appointed each man his work, and reserved the most dangerous or difficult part of it for himself and his man. A spirit of enthusiasm

* The German name of the Ban de la Roche is *Steinthal,* or the Valley of Stone, indicative of its native barrenness.

soon diffused itself over the place ; tools were wanting for a number of volunteers; these were procured from Strasburg, and our good pastor not only expended his own little property in the undertaking, but borrowed assistance elsewhere. The work proceeded admirably; walls were erected to support the earth when necessary, mountain-torrents which had hitherto inundated the meadows, were diverted into courses, or received into beds sufficient to contain them: a neat wooden bridge was thrown over the Bruche, which was named, and still retains its original appellation, "Le Pont de Charité" (the Bridge of Charity) ; and the whole task was completed, and a communication opened with Strasburg within two years from the commencement of the undertaking.

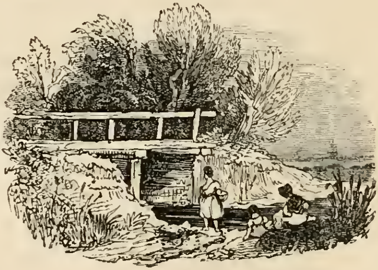
Oberlin, perhaps, was not aware that more than one good man had obtained immortal honour by works like that which he had the ardour to undertake and the happiness to accomplish. He looked for no reward in earthly honours; but yet he ultimately obtained this reward in the success of his endeavours, and the increased influence over his parishioners. They now experienced the benefit of his zealous exertions for their welfare, and cheerfully engaged in his next project, that of forming roads between the four villages of his parish, which were, till his time, in a state of savage separation. The spirit of well-directed industry that had thus been raised made the Steinthal a lively and animating scene. The pastor, who on the Sabbath had directed their attention with that earnestness and warmth wherewith his own soul was filled, to "the rest that remaineth for the people of God," was seen on the Monday, with a pickaxe on his shoulder, marching at the head of two hundred of his flock.

The reader will probably excuse the length of this introduction to the subject of bridge-making. We are so accustomed to the thousands of conveniences which pertain to civilized life ; we use them and enjoy them so much as a matter of course, that it is difficult in the absence of a practical application, to conceive the want and misery attendant on the absence of any one of them. Yet, there was a time when bridges were unknown; when the simple stepping-stones of the brook, or the rude plank thrown across it, were the only means of passing narrow streams of water, dryshod; while rivers of considerable magnitude opposed an insuperable barrier to the inhabitants on either side.



Primitive Bridge.

The foregoing is a specimen of a rustic bridge of the commonest sort beyond the stepping-stones. The annexed cut represents a rural bridge, one degree beyond the former, in having a wooden railing for the convenience and safety of the passengers going over the water.

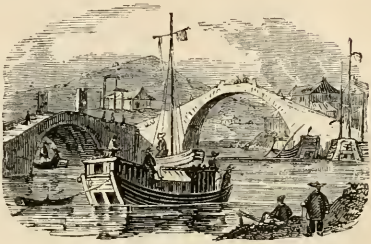


Bridge-making is an art which in our own times has been brought to the highest pitch of beauty and perfection through the skill of modern architects and engineers. The Romans were skilful bridge-builders; but at the breaking-up of their vast empire this art was nearly lost. The Romans have left us many splendid specimens of bridges; but no record of the rise and progress of the art itself. Doubtless, in the infancy of every nation, the first essays contained the rude germs of the art. A fallen tree across a stream would suggest a simple bridge: a cavern worn by the waves, might suggest that wonderful specimen of human ingenuity, the arch; but it is probable that the earliest bridges were formed of lintels of stone or wood of sufficient length to reach from bank to bank, or supported by posts fixed in the bed of the river.

We know so little of the origin of the arch, that the early history of bridge-making is very unsatisfactory. The Egyptians, with all their skill in architecture, do not seem to have been acquainted with the arch. The Chinese seem to have known the arch from remote antiquity, and many of the variations in its structure seem to have been familiar to them. A traveller describes the construction of the Chinese arch thus—"Each stone, from five to ten feet in length, is cut so as to form a segment of the arch; and, in such cases, there is no key-stone; ribs of wood fitted to the convexity of the arch are bolted through the stone by iron bars, fixed fast in the solid parts of the bridge: sometimes, however, they are without wood, and the curved stones are morticed into long transverse blocks of stone. There are, however, arches wherein the stones are smaller and pointed to a centre, as in ours. I have understood that no masonry could be superior to that in the great wall, and that all the arched and vaulted work in the old towers was exceedingly well turned."—BARROW'S *China*.

The ancient Greeks do not seem to have been well acquainted with the useful application of the arch. In their palmy days of luxury, refinement, and splendour, when their beautiful style of architecture had reached its greatest perfection, when their buildings were adorned with the choicest productions of the pallet, and their streets with the noblest results of the chisel, the people of Athens were compelled either to wade or to be ferried over the river Cephisus for want of a bridge.

The Romans, however, observed the error of their Grecian predecessors in slighting the arch in architecture; and they succeeded in rearing the stupendous arch, and the imposing cupola. When they had constructed enormous sewers and aqueducts, together with a cupola over the Pantheon of Agrippa, it was easy for them to throw a stone bridge over their river.

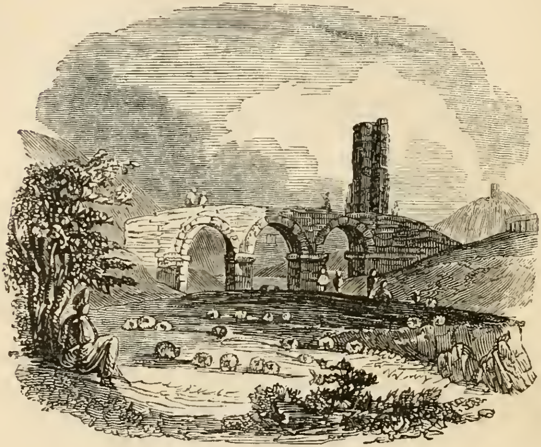


Chinese Bridge.

The Chinese have for so many ages remained, as it were, in a stationary position, following so accurately in the steps of their ancestors, that it were hard to say that the Romans preceded them in bridge-building, and yet it is undoubted that the Romans first communicated to the world the application of the arch to works of public utility. The most noted bridges of ancient Rome were not remarkable for the size or span of their arches, nor for the tightness of their piers, but for their solidity and durability. The span of their arches seldom exceeded seventy or eighty feet; and the height was about half the span: the form was generally semicircular, or a segment nearly approaching to it, as shown in the adjoining cut. The semicircular form of the arch existed universally until within the last half century. Prior to this time, it was believed that the stones of an arch would not retain their hold, if the curve were made elliptical, or only the segment of a circle; and it was only when architects had made bridges with but a slight rise in the middle, and these bridges had stood the test of time, that all doubt of their durability was discarded.

In the construction of a Roman bridge, all the requisites were observed which we meet with in a modern structure: these consisted of *pilæ* or piers; *fornices* or arches; *sublicæ* or butments; *pavimenta* and *aggeres*; the roads in the middle for carriages, on each side of which were *decursoria* or elevated bankments for foot passengers, separated by a railing and sometimes covered over to afford shelter from the rain. The Romans at one time committed the building and repairing of bridges to the priests, (thence named *Pontifices* or bridge-makers); afterwards to the censors and curators of the roads; and, finally, the emperors themselves had the care of the bridges.

The bridges of ancient Rome were eight in number; these, as well as the many bridges also constructed in various parts of their empire, it will be scarcely interesting to enumerate. We will content ourselves with a brief notice of the celebrated bridge built over the Danube, by Trajan, for the convenience of sending ready assistance to the Roman legion, on the other side of the river, in case of a sudden attack from the Daci. Adrian, the successor of Trajan, esteemed this bridge a dangerous friend, because it was as convenient to their enemies as to themselves; and fearing that the barbarians might overpower the guard placed to defend the bridge, and so gain a ready entrance into Mœsia, and cut off the garrisons there, he caused this fine structure to be demolished. This act of pusillanimity may, perhaps, be excused on account of the reason assigned for it: but nothing can excuse the wanton execution of the architect Apollodorus, who was charged by Adrian with facilitating the irruptions of the barbarians into the Roman territory. Just as if the architect erected the bridge on his own account, and for his own amusement; but the real cause of the death of Apollodorus was his high character as an architect, which Adrian foolishly attempted to rival; whereby he incurred not only the ridicule of the Romans, but the sneers of the architect himself. Some of the piers of this bridge are still to be seen in the middle of the river near Warhel, in Hungary. Dion Cassius describes this bridge as consisting of twenty piers of squared stone, each of them a hundred and fifty feet high above the foundation; sixty feet in breadth; and a hundred and seventy feet distant from each other; which was, therefore, the span or width of the arches, thus making the whole length of the bridge about fifteen hundred yards. Doubts have been cast upon this account of the bridge by reference to certain delineations of it in Trajan's column, which differ from Dion's description: but it appears that no attempt is made on the column to offer a model of the bridge, but only to commemorate its existence.



Bridge over the Ilissus.

The annexed figure represents a Roman bridge over the river Ilissus, in Greece.

Passing over the fall of the Roman empire and the age of barbarism which succeeded, we find the Moors in Spain to be the first successful bridge-builders in what is called Modern Europe. The bridge of Cordova over the Guadalquiver is a fine specimen of their skill.

One of the most ancient bridges of Modern Europe is that on the Rhone at Avignon. It was constructed by a religious society called "The Brethren of the Bridge;" which was established upon the decline of the second, and the beginning of the third, race of the kings of France, when the state fell into confusion, and no protection was afforded to travellers, especially in passing rivers; where they were subject to be plundered by bands of robbers. The aim of this praiseworthy society was to afford the required protection by building bridges, establishing ferries and caravansaries on the banks of the most frequented rivers. Their first establishment was upon the Durance at a dangerous spot named Maupas or *bad passage;* but afterwards, when it became more secure, it was named Bonpas or *good passage.* Near this place at Bicançon is a noble bridge. But the bridge over the Rhone, above referred to, seems to have been planned and built by Benezet, who was originally a shepherd; but being frequently warned in dreams to quit his flock and build this bridge, he did so. His youth and inexperience gained him no respect; but by the aid of the Brethren he succeeded, and was canonised as a Saint, when he died in 1187. The bridge was commenced 1176, and completed in 1188. It consisted of eighteen arches—the span of the largest arch was one hundred and ten feet nine inches; and it was forty-five feet ten inches in height. In the same year that witnessed the commencement of this bridge, was old London Bridge begun by Peter of Colechurch who was probably a member of the widely dispersed fraternity of the "Brethren of the Bridge." Previous to the erection of this structure, which was completed in the reign of John, A.D. 1209, a bridge of wood existed, built in the reign of Ethelred II., between the years 993 and 1016. In 1163, it was rebuilt of timber.

This society erected many other bridges, such as that of St. Esprit, over the Rhone, others at Lyons, &c.

The remarkable bridge of the Holy Trinity, over the Arno, at Florence, was built in 1569. It is a beautiful specimen of the arch. A bridge, which is a copy of it, has been built at Cambridge, in the walks of Trinity College.

The art of bridge-building seems to have been cultivated in Britain, with success, from an early period. The oldest structure of this kind, seems to be the Gothic triangular bridge at Croyland, in Lincolnshire; built, it is said, in 860. There are two curious circumstances in the construction of this bridge, which render it an object of great interest to the antiquary. *First*, it is formed by three semi-arches, at equal distances from each other. These unite at the top; and the triune nature of the structure has led some to imagine that it was intended as an emblem of the Trinity. *Secondly*, the ascent on each of the semi-arches is by steps paved with small stones edgeways; and it is so steep, that none but foot-passengers can go over the bridge: horsemen and carriages frequently pass under it, as the river near the bridge is shallow. It is now difficult to determine for what purpose this bridge was erected; it is obvious that utility was the smallest motive for its erection. To boldness of design and simplicity of construction it has strong claims; and it is surpassed in these qualities at least, by no bridge in Europe. Its durability also is not the least of its merits; for although it has been erected so many centuries, it exhibits no symptoms of decay. At the foot of one of the ascents, is the ruined statue of some Saxon monarch, supposed by some to be that of Ethelbert.

In the year 993, the first bridge over the Thames was erected opposite the site of the present St. Botolph's wharf. This bridge was of wood, and a statute of Ethelred II., fixing the tolls to be paid by the "Bylyngsgate" fishing boats, alludes to this bridge.

Previous to the erection of this bridge, there was a ferry, the proprietor of which left it to an only daughter, named Mary, who founded a house of sisters, or a convent near the church of St. Mary Overil, in Southwark, (the present St. Saviour's,) and endowed it with the ferry and its proceeds. This convent was subsequently transformed into a college of priests, who built the wooden bridge, and kept it in repair; till, finding that the expense would be ultimately saved by a greater immediate outlay, agreed with the citizens of London to substitute a bridge of stone.

The wooden bridge had been exposed to many vicissitudes. Soon after its erection it was nearly destroyed by the Norwegian prince, Olaf, who attacked the city in behalf of his ally, King Ethelred, whom the citizens had refused to acknowledge. In 1016, Canute, being prevented by the bridge from sailing up the river, dug a channel at the southern end, and carried his fleet through it to the western side of the bridge. In November, 1091, a violent flood destroyed the greater part of the bridge, and it was repaired by a tax levied on the city by William the Second. In 1136, it was damaged by fire, and though again restored, it was found, in 1163, to be so dilapidated, as to require rebuilding. The college resolved, therefore, as we said, to erect a bridge of stone, and applied to Peter of Colechurch, who conducted the work, and erected an edifice which endured 600 years. This bridge was begun in 1176, a little to the west of the old wooden one. The utility of such a work was so much appreciated, that the contributions to it were considerable,—the king gave to it the proceeds of a tax on wool, and hence arose a popular saying, that the foundations of the old London bridge were laid on wool-packs; the Pope's legate contributed a thousand marks, and the Archbishop of Canterbury, and numerous other persons, were donors to this useful undertaking.

The piers were built on a frame-work of elm piles, driven in as closely as possible, and the intervals were filled in with rubble. The coffer-dams, which were made round each, were never removed, and constituted the *sterlings**, which formed so singular a feature in this venerable structure. The lower courses of the masonry exposed to the action of the water were laid in pitch, instead of mortar; for, at that time, no cement of lime was known, which was capable of *setting* under, and resisting the action of water.

Peter died in 1205; and three merchants of London were appointed to complete the work, which they did in four years more. The bridge, when finished, contained twenty arches of unequal magnitude, and of the pointed Gothic style; the total length of the bridge was 915 feet, and its width, 73 feet.

* More properly, perhaps, *steerlings;* for they were supposed to have been designed for the preservation of the piers, by guiding or *steering* the force of the current or other damage from them.

The master-mason of the work erected a Gothic chapel at his own cost, on the east side of the ninth pier from the northern end of the bridge. This chapel was dedicated to St. Thomas. The lower story thereof was a crypt, and stood in the sterling of the pier, which was extended fifty feet further than the others for the purpose in view: the upper part, or chapel, was level with the road-way of the bridge, and stood partly on the pier, presenting a front to the road, forty feet high, and thirty wide: the length of the whole building was sixty feet. The body of Peter, of Colechurch, was deposited in a stone tomb, in the crypt of this chapel, within the pier of the bridge—a proper burial-place for its architect. This chapel was, at successive times, augmented by several chantries; so that, in the time of Henry VI., there were four chaplains belonging to it, whose stipends were bequeathed by different persons at their deaths. It afterwards became the property of St. Katherine's hospital; and, though it was suppressed as a monastic institution at the Reformation, divine service was performed in it till the beginning of the last century; it was then occupied as a shop, and the crypt converted into a paper-warehouse; and such was the solidity of the work, that though the floor of this story was nearly ten feet below high water-mark, no damp penetrated the walls. In the enclosure of the sterling, in front of the end of the edifice, a fish-preserve had been made, into which the tide carried the fish, and they were secured by a wire grating. A winding staircase led down to this pond from the chapel. This singular and interesting chapel was pulled down in 1760, during some repairs of the bridge.

The arches of the bridge were of different widths; four of the widest, which admitted the passage of larger boats, were called *locks;* and there was a moveable draw-bridge, instead of a stone arch, between the sixth and seventh piers, to admit of larger vessels coming up the river.

There was also a tower erected at each end of the bridge, for the purposes of defence; a general practice at such a time, when, in case of an attack upon the city, the easiest access was, of course, over the bridge. In 1426, a third tower was erected at the north side of the draw-bridge;

and, it is probable, that many houses were about this time also erected on the bridge; for we find an account of the loss of many lives by a fire, about three years afterwards, which broke out in Southwark, and communicated to some buildings on the opposite side of the bridge; and these unfortunate people neglecting to quit their dwellings in time, were enclosed by the flames, and drowned in trying to escape by the river; some were crushed by the falling ruins, and others were burnt in the flames. It is stated that about three thousand lives were lost on this occasion.

A writer in the reign of Elizabeth appends the following description, to a curious view of the bridge in that reign. "This famous bridge is adorned with sumptuous buildings, and statelie and beautifull houses on either syde inhabited by wealthy citizens, and furnished with all manner of trades, comparable in itself to a little city, whose buildynges are so artifycially contryved and so firmly combyned, as it seemeth more than an ordinary street, for it is as one continuous vaute or roof, except certain voyd places reserved from buildings for the retyre of passengers from the danger of cars, carts, and droves of cattle, usually passing that way. The vaults, cellars, and places in the bowels, as it were of the same bridge, are many and admirable, which arte cannot discover to the outwarde view."

A number of these "buildynges" were destroyed by fire, in 1646, and new ones were erected, "three stories high, besides the cellars, which were within and between the piers; and over the houses were statelie platforms leaded, with rails and balusters, and some had pretty little gardens with arbours."

Nonsuch-house, a curious building of the Elizabethan age, made entirely of timber prepared in Holland, was erected on the bridge. It stood near the draw-bridge over the seventh arch, and overhung the river on each side; it was four stories high, richly carved and gilt. The whole frame-work was put together with wooden pegs, no iron being allowed in its construction.

The fire of 1666, destroyed almost entirely this labyrinth of dwellings. Within twenty years they were all erected on a more regular plan; the objection to their presence on the bridge not being yet confirmed. The passage over the bridge was, however, narrow, dark, and dangerous: small security was afforded to foot passengers, and the appearance, both from the bridge and from the river, was unsightly in the extreme. The inconvenience, therefore, of the houses, and of the narrow passage produced by them, being more and more felt, these were all cleared away in 1755, parapets and balustrades were erected on each side; two of the middle arches were thrown into one, to enlarge the water-way; and an archway was opened through the tower of St. Magnus church, for the accommodation of foot-passengers. In this state this venerable structure remained till 1833, when it was finally demolished.

We have been tempted into these details respecting a structure, which is still vivid in the recollection of the present generation. The magnificent bridge which has been substituted for the old one, is so well known, and the circumstances of its erection have been so frequently and so recently detailed, that we need not repeat them. We pass on, therefore, to notice Westminster bridge; our reason for which is to be found in the circumstances attending its erection; which forms an epoch in the art of bridge-building, *caissons* being, for the first time, employed in building the piers. In noticing this bridge, therefore, we will inform our young readers of the general mode of erecting similar structures.

The increased population of the Surrey side of the city of London, requiring more extensive means of communication than London bridge afforded, an Act of Parliament was obtained, in 1736, for the erection of a bridge at Westminster, and John Labelye, a Swiss architect, was appointed to the work.

Up to this time it had been the custom, in the construction of modern bridges, to form a *coffer-dam*, or enclosure of strong piles driven into the bed of the river, large enough to allow of the pier being built within it; this work was made water-tight by means of clay, &c. rammed between two rows of piles; and the water being then pumped out, the foundation could be dug, and prepared without impediment from the action of the stream.

But, in the erection of Westminster bridge, a new plan was adopted. The mud having been removed by dredging, till the firm sand was reached, the surface of this was made level by raking, and tried by repeated measurements, with a proper instrument. The caisson consisted of an enormous chest, formed of timber-beams; the bottom being made capable of separation from the sides, and the whole rendered water-tight while in use. This chest being floated to the proper spot over the prepared foundation, it was secured to fender-piles driven round the place; and the lowermost course of masonry being laid in it, and cramped, the water was admitted into the caisson, by a sluice-gate, and so caused it to sink. It was then ascertained whether it lay truly level on the bed of sand: the sides of the caisson were made sufficiently deep to allow of its edge being above the level of the water when it was sunk; so that, by shutting the sluice, and pumping the water out, it might float again, if need were, with the masonry in it.

If any defect in the level had been discovered, the bed was corrected accordingly; and new courses of masonry being built in that already laid, the whole was again sunk into the precise spot. By these means the pier was raised nearly to the level of low water; so that by availing themselves of the ebb, and pumping out the water, the workmen could soon add new courses of masonry, and raise the work above the level of the high tide. When this was done, the sides of the caisson were detached from the bottom, and floated ashore, to be fixed to a new one, to serve for another pier.

The bridge is 1223 feet long, and 44 wide, between the parapets; there are thirteen semicular arches, besides a smaller one, of twenty feet, at each end, next the abutments; the centre arch is seventy-six feet span, the others decrease in width regularly, both ways, by four feet each. The piers and arches are of Portland stone, the spandrils*

* A spandril, in bridge-building, is the space comprised between the upright line of the pier, the road-way, and the outer curve of the arch.

being filled up with courses of Purbeck stone, laid so as to form an arch, and so adjusted, that the whole mass shall be in equilibrium; each arch is, consequently, independent of the adjoining ones for support.

The piers between the arches form semi-octagonal projections, which terminate at the parapets, in recesses in which are benches for the convenience of passengers: six of these, on each side of the bridge, are arched over with stone.

Before the completion of the bridge, one of the piers sank considerably, in consequence of a quantity of sand for the road-way having been dredged out of the river at a spot too near the foundation, and nine feet below it. It therefore became necessary to take down the two adjoining arches; and the pier being loaded with cannon till all subsidence ceased, was then raised up to a level with the others, and the arches rebuilt. The bridge was opened on the 17th of November, 1750.

The next metropolitan bridge, in point of date, was Blackfriars. It was begun in 1760, and opened in 1771. Mr. Milne was the architect, and, profiting by the example in scientific construction set him by Labelye, he surpassed the performance of the latter, in boldness and elegance of design. The stone, however, which is employed in this structure, is of so perishable a nature, that it is already much decayed, and requires frequent repairs; as many of our readers are probably in the habit of witnessing.

Waterloo bridge, a representation of which is given in the next page, is generally admitted to be the finest in England, if not in the world; though its arches are far surpassed in span † by more recent erections, yet no other bridge unites such simplicity and grandeur of design, with such magnitude. A bridge at this part of the river had, in 1805, been proposed by Mr. George Dodd; but in consequence of much interested opposition, an Act of Parliament was not obtained for it until June, 1809. Mr. Rennie was appointed engineer, who, in June, 1810, offered two de-

* The *span* of an arch is the horizontal distance between the piers or abutments which support it, measured at the points where the arch begins, or *springs*.

Waterloo Bridge, London.

signs for a bridge, one of seven and the other of nine arches, the latter of which was approved. This bridge has a perfectly horizontal road-way; its arches are elliptical, each having a span of 120 feet, and a rise of 38 feet, forming a water-way of 1080 feet. The length of the bridge, between the abutments, is 1380 feet, and its width forty-two feet four inches. The approaches to each end of the pier are seventy feet wide, and are carried over a series of semi-circular brick arches. On the Surrey side, the approach is formed by thirty-nine of these arches, besides an elliptical arch of twenty-six feet span over the narrow-wall-road, so that the total length of the bridge and brick arches, is 2456 feet. This bridge is not national property. It belongs to a company incorporated by the Act of Parliament, which authorized its erection and the payment of a toll.

Bridge over the Dee.

There is a magnificent bridge, called the Dean-bridge which has been lately thrown across the opening formed by the river, or water of Leith, to the north of the city of Edinburgh, which river is called the Dee. It has been erected from a design by Mr. Telford. It consists of two series of four arches each, the one surmounting the other. The latter carries the foot-paths; and from the road-way, which is at the enormous height of about 120 feet above the level of the river below, there is a most extensive view of the Frith of Forth, with the adjacent coast of Fife and East Lothian.

The stone bridges of our own country, as well as of France, are numerous and beautiful, but we have not space to describe them further; our object being rather to show their importance as connecting links between roads, and their influence in promoting civilisation, than than to furnish their history and the details of their erection. There is, however, one bridge which, as a memorial of the patience, industry, and talent, of its remarkable architect, we cannot pass over in silence.

This bridge is probably the most extraordinary of any in our own country. It is thrown over the Taaf, in Glamorganshire, called Pont y Prydd, and was erected by William Edwards, an uneducated mason of that county. In 1746, he built a new bridge at this place, which was universally admired for neatness of workmanship and elegance of design: it consisted of three arches, elegantly light in their construction. The hewn stones were well dressed and closely jointed. But the river flows through a very deep vale, that is more than usually woody and hemmed in with mountains. It is also to be considered that many other rivers, of no mean capacity, besides numberless brooks, that run through long, deep, and well-wooded vales, or glens, fall into the Taaff. The descents into these vales from the mountains being in general very steep, the water, during long and heavy rains, collects into these rivers with great rapidity and force, raising floods such as the inhabitants of open and flat countries can scarcely have a notion of, where the rivers are neither so precipitate in their courses, nor have such hills on each side, to swell them with their torrents. Such a flood unfortunately occurred about two-and-a-half years after the completion of Edwards's first bridge, whereby the largest trees were torn up by the roots, and borne down the river to the bridge, whose arches were not sufficiently wide to admit of their passage; there, therefore, they were detained. Brushwood, weeds, hay, straw, and whatever lay in the way of the flood, came down and collected about the branches of the trees, all which stuck fast in the arches, and choked the free current of the water. In consequence of this obstruction to the flood, a thick and strong dam, as it were, was thus formed. The aggregate of so many collected streams being unable to get any further, rose here to a great height, and with the force of its pressure carried the bridge away entirely before it. Edwards had given security for the stability of the bridge during the space of seven years, he was therefore obliged to erect another, which he proceeded to do as promptly as circumstances would allow him. The second bridge was of one arch, for the purpose of admitting freely under it whatever incumbrances the flood might bring down. The span of this arch was 140 feet, and its altitude 35 feet. The arch was finished, but the parapets were not yet erected, when such was the pressure of the unavoidably ponderous work over the haunches*, that it sprang in the middle, and the key-stones were forced out. This was another blow to a man who had, as yet, encountered nothing but misfortune in an enterprise which was to establish or to ruin him in his profession. But his courage did not so easily give way as his bridge; he soon set about a third structure, and by means of cylindrical apertures through the haunches, so reduced their weight that there was no more danger on this account. The third bridge, which has stood ever since, was completed in 1755, four years after the fall of the second bridge. The arch of the present bridge is 140 feet in span, and 35 feet high. In each haunch are three unequal cylindrical openings, running through from side to side, of nine, six, and three feet in diameter. The width of the bridge is about eleven feet. To strengthen it horizontally, it is made widest at the abutments, from which it contracts towards the centre by seven offsets; so that the roadway is one foot nine inches wider at the extremities than at the middle. We have ventured upon these details, partly to

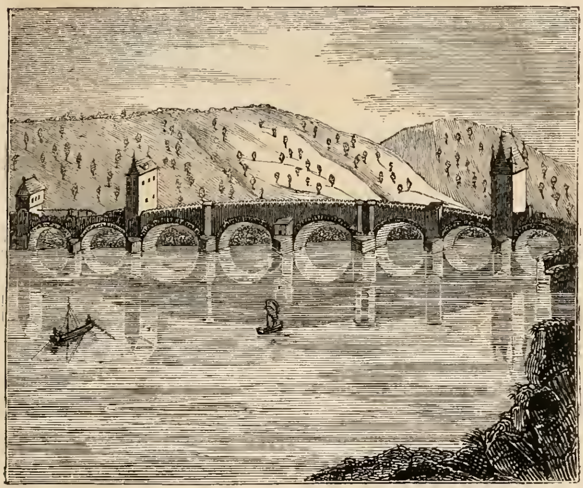
* The *haunches* of a bridge which has but a single arch are the *sides* from which the arch springs.

afford our younger readers a cheering example of what may be done by firmness and integrity of purpose; partly to express our admiration of the performance of a vigorous though uneducated mind, and partly to afford a few particulars respecting a stone arch, which, at the time of its erection, was the largest in the world. The Rialto at Venice, which was planned by Michael Angelo, had been

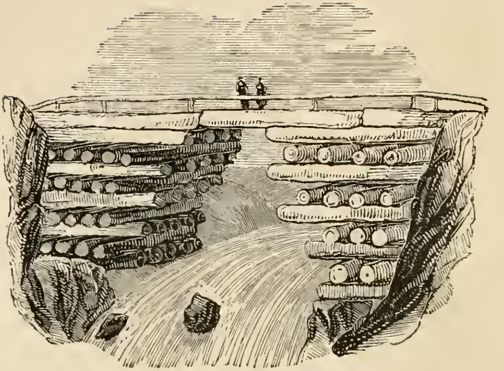
The Rialto.

considered a wonderful structure, because the span of its arch was ninety-eight feet; whereas, that of Edwards's arch was 140 feet span. Edwards's performance gave, as it were, a new impulse to bridge-building; stone arches of extraordinary dimensions were constructed, both in our country and in France: but no one excelled the bridge of our Welsh architect, whose fame now extended far and wide. He built many other bridges, and, in point of convenience, improved upon his first attempt; for he formed his arches of segments of much larger circles than he had ventured to try in the first instance, so that, the roads over them being flatter, the draught of carriages was less, and general travel much easier than with arches formed of segments of smaller circles. All that Edwards performed was done by his own reflection and sagacity; he received instruction from no one—the very principles of masonry he declares he acquired by rambling among the ruins of an old gothic castle in his native parish.

We have thus far noticed those superior structures of stone which are calculated to endure for centuries. There now remain to be noticed several classes of bridges of a less durable description, to a brief notice of which we propose to devote the next chapter.



Ancient Bridge over the Moselle.



Norwegian Bridge.

CHAPTER VIII.

Iron Bridges, History of.—Southwark Bridge.—Telford's Iron Bridges.—Timber Bridges of Germany.—Floating Bridges.—Suspension Bridges of America and Asia.—Conditions of Suspension Bridges.—Telford's Menai Bridge, &c.—Brighton Suspension Pier.—Fribourg Suspension Bridge.—Hammersmith Suspension Bridge.

Among the many remarkable applications of that valuable metal iron, its use in the construction of bridges is worthy of our notice. It has been asserted of the English, as a nation, that with all their powers of application and improvement, they are wanting in invention. It is scarcely worth while to enquire into the truth of this assertion; for in the case before us, the merit is due solely to the English, of inventing, applying, and improving Iron bridges; and it is not unnatural that, with our eminent skill in iron manufactory, that metal should be employed in the construction of bridges, in situations where stone is not easily obtained, or for purposes of lightness and economy. In the iron districts, in particular, bridges would naturally be built of iron, that being the most abun-

Southwark Bridge, London.

dant material, as in well-wooded districts timber would most likely be adopted.

The first iron bridge ever constructed was over the Severn, at Colebrook-dale in Shropshire; the metal for it was cast at the Colebrook-dale foundries by Abraham Darby in 1777, at the great iron-works situate there. The chord is 100 feet, and the arch nearly a semicircle, composed of five iron ribs, upon which the road-way is formed by other pieces of cast iron, and plates which carry the road.

The second iron bridge, cast by Messrs. Walker, in Yorkshire, was as great an improvement on the first in principle, as it was superior to it in size. It was conveyed to London, and exhibited at a bowling-green, near the old church Pancras. It was intended to have been sent to America, but the speculator failing in his payments, the materials were used for the beautiful bridge over the Wear, at Bishop's Wearmouth, near Sunderland. The span of this arch is 240 feet. It is elevated 100 feet above the water, so that vessels of 300 tons burden can sail under it without striking their topsails.

In the same year, 1795, Mr. Telford erected an iron bridge at Buildwas, in Shropshire, which is remarkable as consisting of two arches, one partly sustaining and partly suspending the other.

Vauxhall bridge was originally intended to be of stone; the arches are therefore of less span than was at all necessary for an iron bridge, and although the effect is pleasing, it wants the lightness of an iron bridge of great span.

Perhaps the finest iron bridge in the world is Trafalgar, or as it is more commonly called Southwark, bridge. The architect is Mr. Rennie, who has had the honour of constructing three fine bridges over the Thames at London. Southwark bridge consists of three arches only; the centre one being 240 feet in span, with a versed sine* of only twenty-four, or one-tenth of the chord. The piers are of granite.

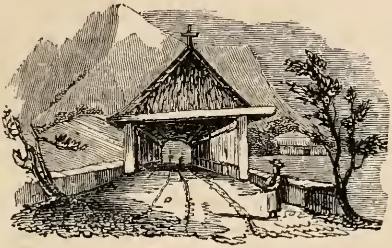
* The *versed sine* in an arch is its height, measured from the *soffite*, or highest point of the underside, to the span-line or *chord*, which is thereby divided into two equal parts.

The largest iron arch ever proposed, but not executed, was when the plans of the new London bridge were being considered. Mr. Telford designed an iron bridge whose span should be 600 feet. Mr. Telford's character stands too high to admit a doubt of his being able to accomplish anything he proposed, and were it not that the present London bridge is so admirable a structure, we should regret that Mr. Telford's plan was not adopted.

We come now to notice TIMBER bridges, which is the most ready, and probably the most ancient, mode of forming these useful structures.

The first recorded timber bridge is by Julius Cæsar, described by him in his *Commentaries.* Palladio has given a design of this bridge founded on Cæsar's own description. He has also described other wooden bridges which are ingenious, and not inelegant; but these we need not stay to describe. At the head of this chapter is a representation of a Norwegian bridge, constructed in a very primitive fashion of logs of wood, and thrown over a torrent.

Germany has been called the school for *wooden* bridges, as England is for those of *iron.* The most celebrated wooden bridge is that over the Rhine at Schauffhausen, constructed in 1758 by a self-taught carpenter named Ulric Grubenmann. The strong current of the river having undermined the piers of a stone bridge which previously existed there, it fell down in 1754, and it was determined to substitute one of timber, which, requiring a smaller number of piers was not so much exposed to similar accidents. Grubenmann offered a model of a bridge without any pier at all, but his project being considered too bold, the authorities insisted that one pier of the old bridge, which was left standing, should be used as an intermediate support. The design was therefore modified, and the bridge was built apparently in one span from shore to shore, but additional support was afforded by beams springing from the stone pier. The length of the bridge was 364 feet, and its breadth eighteen feet. This bridge was destroyed by the French in 1799. John, the brother of Ulric Grubenmann, has also erected bridges with skill, equal to that of his brother. The two brothers in conjunction erected a beautiful structure over the river Limmat near Baden, and another at Writtenghen.



Swiss Bridge.

Wiebecking, who has been called the most skilful carpenter of modern times, has erected timber bridges of extraordinary dimensions. One of these structures is the segment of a circle, the chord line of which measures 639 feet, its versed sine only twenty-six feet six inches, being the portion of a circle whose whole diameter is no less than 3876 feet. The thickness of the framing of this extraordinary bridge is only four feet two inches.

The Americans, having a superabundant supply of timber, have been very successful in the construction of wooden bridges. Timber also abounds in Norway, but, judging from the specimen represented at the head of the present chapter, the Norwegians are sometimes contented with bridges of a rude and most primitive form.

Over the Schuylkill in Philadelphia is a timber bridge named the Colossus, having a span of 340 feet. It was built by Wernwag, in 1813.

Another description of bridges of great antiquity is known by the name of floating bridges, which are in general only temporary works for the purposes of facilitating military operations*; but they are also sometimes adopted as permanent bridges over rivers, examples of them being found at St. Petersburgh, Presburgh, Coblentz,

* The famous bridge of boats formed over the Hellespont, by Xerxes, will occur to the readers of ancient history.

and other towns on the continent of Europe. Others are found of a less permanent nature; as on the Black River, a branch of the Senegal, in Africa, is seen a floating bridge made of trees and bamboos, which is every year carried away by the swelling of the stream in the rainy season, and rebuilt by the people of one of the neighbouring towns.

The principal feature of these bridges consists in a roadway supported by boats of a peculiar construction, which are anchored in a line across the stream. They are very useful on rivers with strong currents, which sometimes bring down large masses of ice, so destructive to the piers of an ordinary bridge. On such occasions an opening is made in the floating bridge by removing the roadway, and unmooring a few boats; or the whole bridge is made to swing round with the current, and lie along the shore till the danger is over. This plan is also available in times of war, when a frontier-town is exposed to the attacks of an enemy; and the facility with which all communication by roads or bridges can be cut off without injury to the bridge is a great recommendation to this contrivance; but still the passage over floating bridges is not at all times pleasant or even safe, since the bridges partake of all the undulations of the stream, and are also greatly affected by strong winds.

The last form of bridges that we shall notice, is PENDENT bridges, or bridges of SUSPENSION, which seem to be derived from the rope bridges of South America and the East Indies, which are well adapted to mountainous countries, where the depth of the valleys is so great as to preclude the erection of piers, and consequently of bridges of stone, iron, or timber; they are also extremely useful, for a similar reason, over very rapid streams.

By referring to the cut at page 9, the reader will understand at a glance the rude and simple mode of crossing torrents and other rapid streams in India, as well as in South America. When Europeans first visited the latter country, they found the *tarabita*, as it is called, used by the natives in crossing the valleys and torrents of the Cordilleras.

Floating Bridge on the Black River, in Africa.

A cable made of strips of hide, or fibres of plants, is stretched across from a post, or tree, on one side, to a wheel on the other; this wheel, or some such contrivance, being necessary to keep the rope tight. A basket is then suspended by loops from the cable, and the basket, with the traveller in it, is pulled across by means of a smaller rope to the opposite shore.

Humboldt describes a bridge, called the Penipe, over the river Chambo, in Quito, of a superior construction to the Tarabita. The main ropes are four inches in diameter, and are laid over frames of timber on each bank, and secured by posts driven into the ground. Over these ropes is laid the road-way, which consequently partakes of the curvature of the ropes, and their instability increases the difficulty of walking over it; there are, however, side parapets, to prevent a person from falling. The span of this bridge is 131 feet.

In the mountainous districts of India and Central Asia, suspension bridges of ropes, or chains, have been in use from the earliest times. The simplest form closely resembles the Tarabita, above described, and is called a Phoola; but we often find descriptions of suspension-bridges of a far superior construction. Over the river Tchin-tchien is a bridge, called *Chuka*-chazum. The river flows between precipitous and rugged banks, in one of the steepest of which is a pyramidal pier of masonry, through the top of which is the road-way; in this opening is fixed a strong frame, like a door-way. On the opposite bank is a second pier, in which a room is constructed, from the front of which projects a covered gallery of timber to the edge of the river, a distance of about thirty-five feet. The floor of the bridge is made by five main-chains of iron, secured to the front wall of the building containing the room; which chains, after passing over the lower beams of the gallery, are attached to the bottom of the frame of the opposite pier. On each side of the bridge is fixed another chain, nine feet above the former, to the top beam of this frame, and, being carried through the wall of the room, they pass down to the ground, where they are secured. Vertical suspending-rods hang from these two upper chains to the outer ones of the floor-chains, to the support of which they contribute, while they form a parapet to the bridge ; the road-way is covered with strips of bamboo. This bridge is very ancient, and a superhuman origin is assigned to it by the natives.

It is remarkable that suspension-bridges were not introduced into Europe until about the close of the last century, although they seem to have been known for at least 2000 years; but the grand discovery of the arch was probably the cause of their exclusion, till, engineers having carried arched bridges to a high degree of perfection, a desire arose for the construction of bridges on a more economical plan, and in situations where the arch, for reasons before stated, was impracticable.

In the Peruvian and Indian bridges, the employment of several ropes was considered necessary to their security, in order that if one were broken, the others might sustain the road till the injury were repaired; also because several short ropes are stronger in proportion than one long one. Similar precautions are necessary when iron chains are employed, whose weight, independently of the road-way which they sustain, requires not only an increase in their number, but an equal degree of strength in every part of them. This latter condition is attained by making each link to consist of several parts united together, because it is easier to make a small bar sound than a large one, and if one such bar in the link should break, it can be replaced; besides, these small rods can be made of forged iron, the tenacity of which is greater than that of cast iron. The links too are frequently made of iron-wire, bound together in numerous coils, the tenacity of which is improved by *drawing*, so that it thus becomes superior even to wrought iron.

It is, of course, well known to the reader that a very long cord, or chain, cannot be stretched into a perfectly horizontal line, in consequence of the attraction of gravitation; it will break long before it approaches a horizontal line. Now it has been found, by calculation and experiment, that there is a certain degree of curvature in a chain, or rope, when employed in a suspension bridge, which is best adapted to stability; and since the lowest part of that curve, or the level of the road, must be sufficiently elevated above the river or valley beneath, the chains must be suspended from some solid fixed object, such as a pier, at each end of the bridge, in order to afford the necessary curvature of the chains. But as no upright structure would be capable of resisting the tension of the chains, simply fastened thereto, it is necessary, after carrying the chains through or over these piers, to bring them down to the ground, and attach them to some other massive and immoveable object.

Since, also, the length of the chains is subject to variation by change of temperature, as well as by vibration, the chains are laid on friction-rollers, which allow motion to them without disturbing the piers to which they are attached. So also, in order to avoid any lateral pressure, which would tend to overthrow the piers, it is necessary that the weight of the suspended mass should exert a perpendicular pressure on them. This is effected by making the chains descend from the piers each way at an equal angle; but this precaution is often sacrificed to other considerations, and the stability of the piers secured by an increase of size or strength, and by their pyramidal form.

A chain-bridge was erected across the Tees, near Middleton, in Yorkshire, about the year 1741; but very little science or skill seems to have been employed in its construction. In 1796, a suspension-bridge was erected over Jacob's Creek, near Greenburgh, in North America; and this seems to be the first important bridge of this nature in modern times.

It was not till about the year 1814, that the attention of English engineers was directed to the subject of suspension bridges. A projected road from Runcorn to Liverpool included a bridge over the Mersey at Runcorn Gap, instead of the existing ferry. Since the navigation of the river could not be disturbed, and three spans only being allowed for the bridge, the centre one of a thousand feet, and seventy feet high; an arched bridge was, of course, impracticable. Mr. Telford proposed a suspension-bridge, and thus reminded English engineers of a practice which has since been extensively adopted.

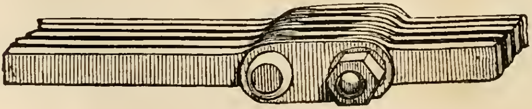
Our limits do not allow us to trace the rise and progress of suspension-bridges in this country, but it will be enough for our purpose to instance two of these remarkable structures, and describe them somewhat in detail.

The Menai suspension-bridge is justly celebrated, as well for the skill of its design and execution, as for its utility. This noble work, of which the accompanying figure will convey an accurate idea, is due to Mr. Telford. It was commenced in July, 1819, and opened in January, 1826.

The passage of the Menai Straits, between the Isle of Anglesea and the Caernarvonshire coast, had always operated as a great impediment to communication; and the advantages were likewise lost of proceeding at once to Holyhead as the nearest point of embarkation for Dublin.

The accompanying view will not only convey a just idea of suspension-bridges generally, but will render a minute account of the work itself unnecessary. The distance between the piers at the level of the road is 551 feet; the road-way is 102 feet above high-water level, and is 28 feet wide, divided into two carriage-ways of 12 feet each, with a foot-way between them of 4 feet.

There are sixteen main chains, the links of which consist of five wrought-iron bars, 10 feet long, $3\frac{1}{4}$ inches broad, and 1 inch thick; so that there are in all eighty such bars. The links are connected by means of coupling links, 16 inches long, 8 broad, and 1 inch thick, as shown in the annexed figure, which shows the junction of two



contiguous links; each bolt-pin is 3 inches in diameter, and weighs 56 pounds. The chains are arranged in sets

The Menai Bridge.

of four, one under the other; one set on each side of the central foot-path, and one set on each of the outer sides of the bridge. The chains, after passing over the piers, descend to the earth, and are conveyed through three tunnels cut in the solid rock on each shore, and are held in chambers at the end of the tunnels by means of twelve bolts, each 9 feet long, and 6 inches in diameter, resting in sockets in cast-iron plates. The chains are provided with suspending-rods, cross-ties, &c., to prevent vibration and lateral motion from the effects of wind, &c. The chains lie on cast-iron saddles on the top of the piers, these saddles resting on friction-rollers, carried by a fixed iron bed; the saddles, therefore, move with the chains when these undergo any variation from temperature.

In setting up the chains, the parts within the tunnels were put together link by link, from the holding-bolts at the bottom; a scaffolding was erected from the mouths of the tunnels on the masonry, supporting a platform of the requisite slope, reaching to the tops of the piers; the chains were put together on this platform till they reached over the saddles. A cradle capable of holding two workmen was suspended by tackle from the top of the pier on the Caernarvon side, in such a manner that the men could raise or lower it themselves as they required. The links were brought to the face of the pier next the sea through the archway; from thence each link was raised to the required height: it was then attached to the last link by the men in the cradle. In this way the chain was lengthened downwards to the level of the water. The other portion of the chain, which was to unite the two ends, was laid on a raft 400 feet long and 6 feet wide; one end of the chain on the raft being fixed to the end of the chain hanging from one pier, the raft was floated across, and the other end of the chain lying on it was attached by the second link to a powerful tackle, which was raised by two capstans on shore, till the chain was elevated to the height necessary to admit of a union between the two ends. In this way all the chains were got up.

The road-way suspended from these chains consists of two thicknesses of planks, forming a thickness of five inches; the under planks are bolted to the wood that fills in the intervals between the road-way bars. This planking was covered with felt saturated with boiled tar, and the upper thickness was placed over this felt and spiked down to the lower one. In the middle of each carriage-way there is a third layer of plank, placed on felt as before; the road-way is also stiffened by means of an oak plank bolted to the underside, between each cross-bearer.

We shall not justly estimate this noble structure unless we remind the reader that there had not been as yet any performance on such a scale of magnitude and difficulty; whereby to assist and guide the engineer as a pattern. When a great work is once established, and in action, it is comparatively easy to take it as a model, whereby to follow out, and extend its principle, to avoid its defects, and to institute such useful variations and improvements as experience may suggest. Few men are so gifted by nature, by education, and by co-operating circumstances, as to discover an unknown principle, or law of nature; but when this is revealed, how simple becomes the application of crowds of illustrative facts, and how rapidly are old facts varied, and new facts discovered! We, therefore, regard Mr. Telford as one of the gifted few whose genius led him to invent a model which places him on a level with such benefactors of our species as an Arkwright, a Watt, or a Brindley.

Among the useful roads which enable men to communicate with each other, we must not forget PIERS, or roads stretching out into the sea from sea-coast towns which have not the advantage of a natural harbour, or port, whereby in such a case all approach to the town by sea is inconvenient, and in rough weather impracticable. Such a town was Brighton, previous to the erection of a suspension-pier.

The skilful Captain Brown is the engineer of the Brighton suspension-pier. It was commenced in October, 1822, and finished in November, 1823. This work extends 1014 feet into the sea from the front of the esplanade wall. The entire length is 1136 feet, and is divided into four spans of 225 feet each. The platform is 13 feet broad.

There are eight main chains carried over pyramidal cast-iron frames, 25 feet high, resting on piles; the extreme pile at the head of the pier is spread out laterally, and is covered with granite paving, weighing upwards of 200 tons; the object being to afford a firm base for the back-stay chains which are bolted to diagonal piles constructed in the extreme pile.

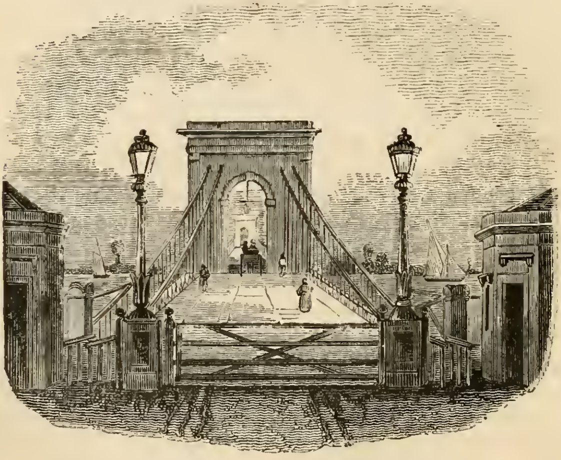
At the land-end the main chains are carried over a pier of masonry, and through two tunnels cut in the cliff, 30 or 40 feet deep; and secured in a brick chamber to massive stones, by means of a ponderous plate of cast-iron.

This beautiful pier was greatly injured, if not destroyed, by a tremendous gale, during the night of the 15th of October, 1833. The platform between the first and third piers was almost entirely destroyed; all the suspension-rods broken, and the main chains much deranged, while the weight of the road-way being removed, the chains over the first and fourth spans were so much depressed, that the platform they supported was also greatly injured.

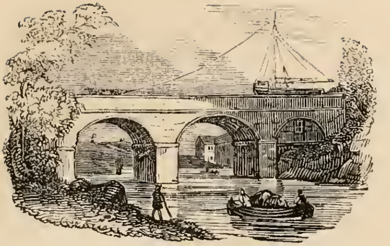
Suspension-bridges generally are subject to a vibratory motion, which is not only unpleasant to passengers, but is injurious to the structure itself. However ponderous a body may be, if suspended so as to vibrate, a slight force, if repeated at equal intervals, produces that motion which is frequently sufficient to produce a rupture. It is stated that a suspension-bridge at Broughton, near Manchester, was broken down, in April, 1831, by a party of sixty soldiers marching over it to a tune on a fife. The bridge would have borne more than double the weight if the men had gone over it in an irregular step; but the equal timedness of the march produced so great an oscillation in the main chains, as to break them. It has been suggested that the damage done to the Brighton pier was by gusts of wind acting probably at equal intervals of time.

There is a very fine suspension-bridge at Fribourg, in Switzerland, constructed with wire-cables by M. Chaley, the French engineer. We may also remind the reader of the fine structure at Hammersmith, designed and erected by Mr. W. T. Clark, which presents the peculiarity of part of the road-way being supported on, and not hanging from, the main chains.

This bridge was opened in 1827, after having been about three years in erecting.



Hammersmith Suspension Bridge.



CHAPTER IX.

Importance of Canals.—Canals of the ancient Greeks, Romans, and Egyptians.—Canals in China.—Modern Canals of Russia, Holland, France, and Great Britain.—Duke of Bridgewater's Canal. — Brindley. — Construction of Locked Canals.—Caledonian Canal.

The author of the *Wealth of Nations*, after expatiating on the value of good roads to the community, and the manifold advantages to be derived from them, says: "But how much greater must be the advantages of Canals, on which one horse will do the work of twenty or thirty horses in the transport of goods, and one boy and a man the work of ten men; that is, one man, a boy, and a horse, are sufficient for transporting, by a canal of the smaller class, twenty tons' weight of merchandise, which on the best roads would require at least twenty horses and ten men. The expense of carriage, therefore, would be at least ten times as great, and the wear and tear proportionably greater."

The word "canal" is derived from *canalis*, the Latin for a thing hollowed out like a *cane* or reed. Virgil uses the term when speaking of a *trough*. But, as we generally understand the term in reference to inland navigation, it is a piece of water whose length is of more importance than its breadth.

Although in this country canals, at their first introduction, had to share the fate of most new and useful inventions, in encountering much opposition, their value seems now to be generally admitted, even at the present time, when rail-roads are being so extensively and universally adopted. On the first introduction of the latter mode of conveyance, it was supposed that canals would no longer be required; and it was suggested to draw off the water from most of them, and convert them into lines for rail-roads: but experience has hitherto shown, that the rail-road is not a desirable mode of transport for goods whose value is small compared with their weight, on account of the great expense of carriage; so that, where expedition is not an important object, canals will always continue to be desirable for the transit of a vast amount of heavy articles, such as road-making materials, manure, fuel of various kinds, metallic ores, &c.

We find many accounts of canals among the ancients; and even in Greece, which, from its peculiar geographical construction, would seem not to require the aid of canals, we find traces of them. Some of the Roman Emperors attempted to cut through the isthmus which connects the Peloponnesus or Morea with the rest of Greece. In Bœotia traces of canals are found, originally cut for the purpose of carrying off the water from the flooded lands. The aqueducts of the Romans were a species of canal; and they also had many canals for drawing off the water from flooded lands.

From the earliest times canals seem to have been dug in Egypt, for receiving and distributing the waters of the Nile, at the time of its annual overflow; there was also a grand project of a canal between the Nile and the Red Sea. The works are said to have been commenced by Necos, and continued by Darius; but a fear arose that all Egypt would be inundated, and thus the plan was abandoned. The second Ptolemy, however, proceeded with the undertaking, and completed it. He caused a dam, or sluice, to be constructed, which was only opened to allow a boat or other vessel to pass. The passage of this canal occupied four days. It afforded a means of conveyance for the rich commodities of India, Persia, Arabia, and the southern coasts of Africa. These were conveyed from the Red Sea down the Nile to Alexandria, whence they were shipped to different parts of Europe. After the time of

Ptolemy, this canal fell into neglect, but one of the caliphs, A.D. 635, restored it; it was then suffered to fall into ruin, and only a few traces of it now remain to excite the speculations of the traveller. The canal of Alexandria, called by the Arabs the Canal of Faon, was cut from a place now named Rhamanie to Alexandria, for the purpose of supplying water to this city, whence also proceeded a canal to Canopus.

China has long been celebrated for its canals. Most of my young readers will have heard of the Grand or Imperial Canal, extending from north to south more than 400 miles, cutting in its course several rivers and smaller streams, and affording a constant supply of water. The skill displayed in many parts of this stupendous work is also remarkable. In order to accommodate the general level of the canal to the respective levels of the streams which supply it, it was necessary in some places to cut to the depth of sixty or seventy feet below the surface; and in other cases to raise mounds of earth upon lakes, swamps, and marshes of large dimensions. Some of these enormous embankments are carried through lakes of vast extent, and the water between the embankments is maintained at a level considerably above that in the lakes; sometimes, too, the water of this canal moves along at the rate of three miles an hour, for the bed is level only in a few places. Flood-gates are thrown across it in certain situations, for the purpose of elevating or depressing the height of the water when necessary, so as to maintain a general level. Sluices are also constructed in the sides of the embankments for draining off the redundant water. The construction of the flood-gates is very simple. They consist of planks sliding in grooves cut into the sides of two stone piers, which, in the places where they are situated, contract the canal to the width of thirty feet. At each set of flood-gates there is a guard-house, with soldiers, to protect the place, and to draw up and let down the hatches as occasion requires. From the river Hohang-ho to Kian-ku the country abounds in lakes and marshy grounds; and in some parts the canal is carried twenty feet above the level of the country, and the width is often

200 feet. This canal has no locks, and with the exception of the flood-gates, no interruption to navigation occurs throughout its whole extent. It is stated that there is a passage by canals almost from one extremity of the Chinese empire to the other: that is from Pekin in the north, to Canton in the south, the distance being estimated at 920 miles, along which vessels may pass with only one interruption, which is a mountain.

The canals of China are probably the most ancient in the world; those of Russia are perhaps (if we except our own country) the most modern. From the generation of this vast empire by Peter the Great, it has been alive to every species of improvement which civilization affords. After founding the city of Petersburgh, Peter formed the plan of an inland navigation from Persia to his new city. Merchandise was to be brought by the Caspian Sea to Astracan, and thence by the Wolga; a line of canals was then to convey it into the river Mesta and the Novogorod lake; then into the lake of Ladoga, and to Petersburgh by the river Neva,—a distance of 450 miles. Peter also designed a navigation from the Don to the Wolga, and another canal to the river Occa, and thus to arrive at Moscow; and then a line was to communicate with Archangel. An English engineer, Captain Perry, was appointed to superintend the works, and they proceeded until the Czar's death, in spite of considerable opposition on the part of the nobles or boyars. The successors of Peter have, however, completed most of these fine plans, which confer so great an advantage on Russia, as may be seen when we state that goods may be conveyed nearly 4500 miles by water, from the frontiers of China to Petersburgh, with only one interruption of sixty miles. Another completed line of upwards of 1400 miles, reaches from Astracan to Petersburgh. There are also many other smaller canals in Russia.

The canals of Holland form the principal feature of this singular country, which, by the ingenuity and labour of man has been withdrawn from the dominion of the sea. The provinces of this country are intersected with a vast number of canals, which form, in fact, the *high roads* of the Dutch; along which they are constantly travelling and conveying goods from one to another, in summer by means of boats and barges, and in winter by sledges and skates. Their canals also communicate with many parts of France, Flanders, and Germany. The profits of this mode of conveyance are also very great. Mr. Philips states that, for one distance of forty miles, an annual profit of 250,000*l.* is, or was, commonly obtained.

The canals of France are very considerable. Perhaps the finest is that of Languedoc, or the canal of the two seas, forming, as it does, a junction between the ocean and the Mediterranean. But our limits do not permit us to describe the canals of France and of other nations; nor, indeed, is it necessary that we should do so, since the general features of all canals being so much alike, a mere catalogue of their names, the geographical description of their lines, and the dates of their construction, would not sufficiently interest the general reader to warrant the insertion in this little volume. We pass on, therefore, to a brief history of the canals of our own country.

The English did not adopt the use of canals before the year 1755, when the first canal was constructed by the proprietors of the Sankey navigation, in order to make the Sankey brook navigable from the Mersey to St. Helen's. The length of this canal was $12\frac{1}{2}$ miles.

This performance probably suggested the first grand work of the kind which was constructed in England, namely, the Duke of Bridgewater's canal. Francis, Duke of Bridgewater, succeeded to the family estates, while yet under age, in the year 1748. Part of his property was at Worsley, a few miles to the west of Manchester, and the coal-mines of this place were very rich, but left unproductive, for want of some cheap means of transport. The young Duke, therefore, considered earnestly the means of supplying this defect. The Duke's father had, in 1732, obtained an act of Parliament empowering the construction of a canal to Manchester, but feared to begin the work on account of the natural difficulties thereof, and the great cost which it must necessarily entail upon him and his family. Besides this, there was probably no engineer capable of such an undertaking; and it was not until Brindley became known, that the idea of the canal was resumed, when the young Duke applied to him to survey the line and report thereupon. To a mind like that of Brindley, a new and difficult undertaking was peculiarly adapted. Confident in the strength of his own inventive resources, he reported favourably to the Duke, who at once resolved to commence it; and in 1758 he obtained a second act of Parliament, enlarging and extending the powers granted by the first; so that the works were that year begun.

One of the difficulties of the undertaking was a due supply of water. In order therefore to prevent waste, it was determined to maintain a horizontal level throughout, so that no locks would be necessary; in consequence of which, the line extended over wide valleys, and through high hills. A spacious basin was formed near the centre of the coal-district at Worsley; a tunnel, three quarters of a mile long, was then cut through a hill, on emerging from which the line was carried straight-forward on the same precise level, until it reached Barton. A stupendous aqueduct was then to be constructed over the Irwell, in such a way as not only to preserve the level of the canal, but also not to interrupt the navigation of that river; this required a height of 39 feet for the aqueduct above the level of the river. As soon as Brindley's intentions to construct this aqueduct were known, they were universally denounced as wild and visionary, and the plan accordingly pronounced impracticable. But in order to justify his conduct towards his noble employer, Brindley desired that an eminent engineer might be called in to give his opinion respecting the proposed aqueduct. The report of this gentleman is memorable: "I have often heard," said he, "of castles in the air, but never before was shown where any one of them was to be erected." This sneer did not however, disturb the confidence of the Duke in his own engineer; he immediately ordered the plan to be proceeded with; and such was the rapidity and success with which the aqueduct was effected, that those who had publicly denounced it as chimerical were astonished and confounded. This work was begun in September, 1760; and, within ten months, the first boat sailed over it on the 17th July in the following year; from which time it was not uncommon to see a barge loaded with forty tons drawn with ease over the aqueduct, while ten or a dozen men were often seen below toiling painfully to direct a smaller load against the stream of the river. The work was then completed as far as Manchester.

This noble canal reflects infinite credit upon its undertaker, as well as upon his engineer. The former devoted his fortune to the work, and even limited his own personal expenses to £400 a-year, in order to extend his means for the undertaking. It would be an interesting narrative to detail minutely the toils and anxieties which his favourite scheme produced to the noble Duke: we find him thus voluntarily renouncing the dignities and the enjoyments of his station; often encountering commercial difficulties; unable at times to raise money; but still never tiring in his activity, or abating his zeal for the completion of a work which is now associated with the wealth and prosperity of our country. The duke and his family were, however, amply rewarded by the success of the undertaking, and the public was greatly benefited. As an example of the latter, we may state that goods had been conveyed between Manchester and Liverpool at the charge of twelve shillings per ton by water, and forty shillings by land; but by the canal they were conveyed for six shillings per ton.

So justly celebrated did Brindley become by the construction of this canal, that before its completion he was applied to, to connect the Trent and the Mersey by a like undertaking. Here again the engineer had vast natural difficulties to encounter; in one case, a tunnel was carried through Harecastle Hill, 2880 yards in length, and sometimes more than 200 feet below the surface of the earth. There were five tunnels to this canal, 76 locks, and several aqueducts. Indeed Brindley not only excited the astonishment of the public generally, but that also of contemporary engineers. His various inventions and fertile resources were perhaps equalled only by the beauty and simplicity of the results produced. He seldom or never constructed models or plans; but, when any difficulty occurred, his custom was to retire to bed, and there meditate upon the best means for overcoming it. He has been known thus to seclude himself for days together. So much attached was he to canal-navigation, that on being examined before a Committee of the House of Commons, and speaking slightingly of rivers for the purposes of inland navigation, the question was jocosely put, "Of what use then are rivers?" to which Brindley replied, "Undoubtedly, to feed navigable canals."

From the time of Brindley, the great advantages of canals to the commercial and manufacturing interests of this country became duly appreciated, and new lines of canals were speedily begun and completed, the bare enumeration of which would occupy many pages. The number of canals in Great Britain is 103; the total extent is 2688 miles, and the capital sunk in their construction is computed at upwards of thirty millions of pounds; nearly the whole of them have been completed by the combined exertions of private individuals.

It will be seen from some of the above statements that the construction of a canal in a level country is a very simple affair. All that is necessary being to dig a bed or channel in the earth, and throw up the soil on each side. When the soil is loose and porous, the floor and sides of the canal must be lined with some substance through which water will not pass; this operation is called *puddling*, and need not be described particularly.

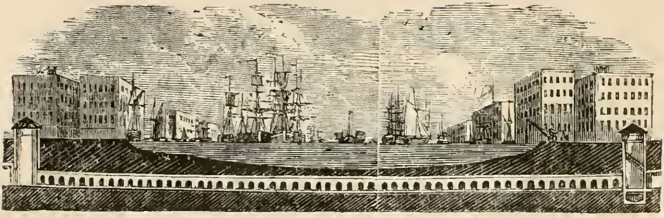
Since a canal is a mass of still water, exposed to certain losses by leakage and evaporation, it is necessary to construct reservoirs which shall be supplied by streams or springs in the vicinity of the line; and from these reservoirs the canal receives its due supply of water.

In cases where, from the nature of the ground, a perfect level cannot be produced, systems of *locks* are adopted. A lock may be described as a chamber of masonry, occupying the whole bed of the canal at the particular spot where the level varies. The water in this chamber is made to coincide with either the upper or lower level of the canal; and this is done by a pair of gates at each end of the chamber of the lock; so that supposing a vessel to have to pass from the lower to the upper level, while the gates at the end of the chamber where the water is lowest are opened, the water in the chamber coincides with the upper level; a boat or barge then enters through the opened gates which are closed upon it; the other gates are then opened, and the water in the chamber rises, and coincides with the upper level; the boat is then drawn onwards, the gates are again closed, and the whole amount of water transferred from the upper to the lower level is that contained in the lock between the flood-gates. By a reverse process it will easily be seen how a boat may be transferred from the upper to the lower level. Since it is desirable to lose as small a quantity of water as possible in the passage of boats through these locks, they are made as narrow as possible; and the lock is often made with two divisions, which communicate by means of a valve or hatch; so that one-half of the water which would otherwise be transferred to the lower level, is let into the other division of the hatch between the closing of the gates of the upper, and opening those of the lower level.

A locked canal is therefore a series of ascending or descending stairs; and a magnificent staircase of this description is exhibited in the Caledonian Canal, which passes through a chain of lakes and narrow arms of the sea, and affords an inland navigation of 250 miles across the central part of Scotland. There are 27 locks; and the lockage up and down is equal to 190 feet. These locks, with one exception, are 180 feet long, and all of them 40 feet wide; thus opening a ship-navigation through the midst of the country, and rising at the highest level, 94 feet above the tide-water of the eastern, and $96\frac{1}{2}$ feet above that of the western-coast. At Fort Augustus this canal is cut through the glacis of the fortification, which improves the military defences as well as the appearance of the fort, and presents, with five rising locks of masonry, a splendid combination of military and civil engineering. From Loch Ness, passing westward, to Loch Oich, the land is 20 feet above the water-line; which, with the depth of water in the canal, forms an excavation, $1\frac{3}{4}$ mile long, and 40 feet deep. In descending westward to Loch Lochy from Loch Oich, the natural difference of the surfaces of the two lakes is 22 feet, and to save cutting through a rock, the whole area of Loch Lochy which is 10 miles long, and one mile broad, is raised 12 feet. In the last two miles before the canal enters Loch Eil, there is a descent of 64 feet, which is passed by eight magnificent locks of the dimensions as stated above. These locks are founded on inverted arches connected together, and forming a solid continuous mass of masonry, 500 yards long, and 20 yards wide, with flood-gates of cast-iron. This system of locks has been named *Neptune's staircase;* and the appearance of the large vessels in these enormous locks descending from the hill towards Loch Eil is described as majestic and imposing in the extreme, and exhibits a striking instance of the triumph of art over nature. The total ascent of this canal by locks is 94 feet, and the descent also by locks, 96 feet and a-half; thus showing a difference of $2\frac{1}{2}$ feet between the levels of the two seas. The Caledonian Canal was opened on the 23rd of October, 1822; the entire cost of its construction has been estimated at £912,500; the engineer to whose genius and skill the work was intrusted was Mr. Telford.

This slight sketch of canals will enable the reader to estimate their value. Spreading as they do in so many directions from coast to coast, and penetrating into our most inland districts, a facility is afforded for the conveyance of materials of all kinds; the boat which conveys corn to one place may return laden with manure; it may convey besides corn, lime, iron ore, and coals; and return with the iron manufactured into articles of constant use, and demand, both at home and abroad; it may convey the raw cotton to the seat of manufacture, and return with cotton goods for exportation; and all this may be done with so much ease that a load of more than twenty tons may be drawn by a single horse at the rate of two miles an hour. It may be objected that this is but a sorry pace; but it must be remembered that at a slow pace, as regards tractive force no means of conveyance can come in competition with canals. With the increase however of manufactures and commerce, time is, indeed, a valuable element, and the charge of transport often becomes of less account than the time employed about it; the wonderful speed which the railway affords is its greatest recommendation; and to the details of this subject we shall devote much of the remainder of this volume.

It is not always easy to say whether roads engender commerce, or whether commerce is the parent of roads; but it is evident that they act upon each other on the same principle as two magnets: that is, each one strengthens and improves the other. So long as the internal traffic of Spain, for instance, is carried on by muleteers instead of by coaches, wagons, canals, steam-boats, &c., we may look in vain for the extension of commerce in that unfortunate and misgoverned country. Muleteers sound very well in songs and romances; but if we had to bring our teacups from Staffordshire, our knives and forks from Sheffield, our cotton from Manchester, and our woollen goods from Leeds, on mules' backs, for want of good roads and canals, our commercial progress would be marvellously slow.



The Thames Tunnel.

CHAPTER X.

On Tunnels.—Uses of Tunnels.—Natural and artificial.—Natural Tunnel in America.—Medway, Edge Hill, and Thames Tunnels.

"Tunnel" is a name given to an arched opening which passes through a hill or an elevated portion of country, having a place of exit at each end. If we adhere to this definition, we shall find tunnels of various sorts. A natural archway through which water can pass,—a similar archway, but constructed by art,—a dry cavern, passing through the bowels of a mountain,—and a similar cavern, but made by the hand of man,—may all be called *tunnels.* We may therefore divide tunnels into three classes; viz., natural and artificial tunnels for the passage of water, and artificial tunnels fit for land-travelling. A description of all the excavations which might belong to this classification would absorb the whole of this work. We will, therefore, select one instance of each, by which the reader can judge of the rest.

In the passage of rivers through mountainous districts, it often happens that they have gradually worn away the subsoil beneath a rock, and forced for themselves, in the lapse of ages, a passage beneath or through a mountain. In other cases, a volcanic eruption, or an earthquake, has disturbed the geological features of a district,—made rents and chasms in various parts, and thrown two or more rocks out of their original positions, in such a manner as to leave a cavernous opening between them, through which a river may ultimately flow.

Many such instances as this have been met with in various parts of the world; and in which it is not always easy to say whether a cavern or a tunnel has been excavated, or worn away by a river, or has been formed by one of those sudden convulsions of nature, which show us how fragile is the crust of our earth, when put in competition with the mighty elements working within it. We will select an instance from the other side of the Atlantic.

The state of Virginia contains many specimens o rocky bridges, naturally formed over a brook or river; bu the one to which we now allude could scarcely be called a bridge; it is more properly a tunnel bored by nature's own hands through a hill, along which a stream flows. The existence of this tunnel was long known, but its details were so little understood, that Lieutenant-Colonel Long, of the United States army, resolved to pay it a visit; and communicated the result to the *American Journal of Geology and Natural Science*, a few years ago.

He says, "Saturday, August the 13th, 1831. Having ascended Cove Ridge, we turned aside from our route to visit the natural bridge, or tunnel, situated on Buck-Eye, or Stock-Creek, about a mile below the Sycamore Camp, and about one and a-half mile from a place called Rye-Cove, which occupies a spacious recess between two prominent spurs of Powell's mountain, the site of the natural tunnel being included within a spur of Cove Ridge, which is one of the mountain-spurs just alluded to. Here is presented one of the most remarkable and attractive curiosities of its kind, to be witnessed in this or any other country. The creek, which is about seven yards wide, and has a general course about S 15 W, here passes through a hill elevated from two to three hundred feet above the surface of the stream, winding its way through a huge subterraneous cavern or grotto, whose roof is vaulted in a peculiar manner, and rises from thirty to seventy or eighty feet above its floor. The sides of this gigantic cavern rise perpendicularly, in some places, to the height of fifteen or twenty feet, and in others, are formed by the springing of its vaulted roof immediately from its floor. The width of the tunnel varies from fifty to one hundred and fifty feet. Its course is that of a continuous curve, resembling the letter S; first winding to the right as we enter on the upper side, then to the left, again to the right, and then again to the left, on arriving at the entrance on the lower side. Such is its peculiar form, that an observer, standing at a point about midway of its subterranean course, is completely excluded from a view of either entrance, and is left to grope in the dark through a distance of about twenty yards, occupying an intermediate portion of the tunnel. When the sun is near the meridian, and his rays fall upon both entrances, the light reflected from both extremities of the tunnel, contributes to mollify the darkness of the interior portion into a dusky twilight. The extent of the tunnel, from its upper to its lower extremity, following its meanders, is about one hundred and fifty yards; in which distance the stream falls about ten feet, emitting, in its passage over a rocky bed, an agreeable murmur, which is rendered more grateful by its reverberation upon the roof and sides of the grotto. The discharge of a musket produces a crash-like report, succeeded by a roar in the tunnel, which has a deafening effect upon the ear."

As an example of an artificial tunnel excavated for the passage of water, we may take the tunnel under which the water of the Thames and Medway passes, in its course from one of these rivers to the other; such tunnels as these are occasionally constructed for canals, in order to avoid the great number of locks which would be necessary, were a canal carried over a high tract of country. There is a canal running completely under the parish of Islington, for instance, through a tunnel three-quarters of a mile in length.

A similar tunnel is the one represented in the annexed cut, and which forms part of the Thames and Medway canal. This canal was projected about the end of the last century, by Mr. Ralph Dodd, the original projector of a dry tunnel under the Thames. The passage from Gravesend to Chatham, round by way of the Nore, is very circuitous, and entails a great loss of time, for barges, &c., which have to go from one to the other. It was, therefore, urged by Mr. Dodd, that a canal connecting the two, (which are not more than about seven miles from one another,) would be of great service to the inhabitants of the surrounding parts.

After some time, and certain changes in the plan, a canal was cut in that quarter, which was commenced early in the present century. It extends from the Thames at Gravesend, to Frindsbury, opposite Chatham. It has a basin at each end; and passes, by means of the tunnel which we have represented, through the chalk hills which skirt Gravesend. This tunnel is about two miles in length. There are but few canals in England, which effect a greater ratio of saving in the distance leading from one place to another, by barge or boat, than that of which we are speaking; the distance from Gravesend to Chatham being about forty-seven miles, round the extremity of the Isle of Grain, and, as we have said, only about seven or eight by way of the canal to which we here allude.

The tunnel is no larger than will conveniently admit the barges, and a towing-path for the horses at the side. But the main part of the canal is fifty feet in width, and is one of the very few in England that are perfectly level.

We shall make the Thames tunnel our instance of an artificial tunnel for land-travelling. But, as this differs from most of the kind, in passing under the bed of a mighty river, we will say a few words respecting those which pass under a large tract of country, but only under small rivers.

Our railroads furnish the most notable instances of these. We shall hereafter have to state, in our Chapter on Railroads, the reasons why a railroad must be as level, and as little influenced by the undulations of the surface of the country, as possible. But one of the effects of that necessity is, that tunnels must, frequently, be excavated through elevated tracts of country.

In order to make the Manchester and Liverpool railway as valuable as possible to the merchants of the latter place, it is carried down very near to the docks, so as to allow goods to be conveyed from the ships to the railway with as little intermediate travelling as possible. To effect this, the railway is carried, by means of a tunnel, completely under the greater portion of the town of Liverpool. This tunnel is level for a part of its length, and inclining downwards, towards the docks, for the remaining part.

The subjoined cut represents the upper end of this tunnel, at Edge Hill. The first shaft of this tunnel was opened in September, 1826. It is twenty-two feet wide, and sixteen feet high. The sides shoot up nearly perpendicular to a distance of about five feet from the ground, and this part is surmounted by a semi-circular arch. The length of the tunnel, from end to end, is two thousand two hundred and fifty yards,—about a mile and a quarter. One of the entrances is at the company's yard at Wapping, Liverpool; and the other at Edge Hill, as represented in the engraving. The former entrance is by an open cutting, twenty-two feet deep, and forty-six feet wide, and affording space for four lines of railway.

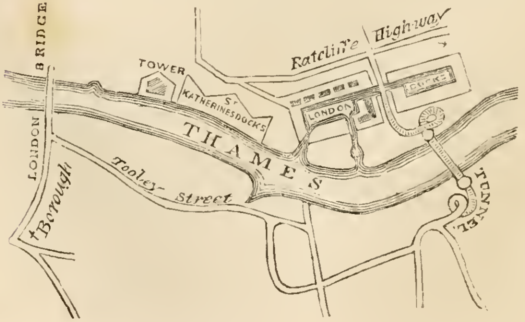
From this opening, the railroad commences along a perfect level, which occupies about two hundred and eighty yards of the length of the tunnel. After this, the inclined plane commences, and extends one thousand nine hundred and seventy yards, in a perfectly straight line, and with an inclination of one yard in forty-eight,—the entire rise of the tunnel being one hundred and twenty-three feet. A large portion of this tunnel was excavated through a solid rock of fine red sandstone, which in those parts furnished the engineer with a natural and secure roofing, requiring neither masonry nor brick-work. But, in other parts, the material through which the excavation was carried, was too loose and weak to support itself, unless masonry were immediately applied.

The construction of the tunnel was carried on at seven or eight different parts simultaneously, by sinking as many shafts, in different parts of its length, and connecting one shaft with another, by lateral excavation; the stone and earth being removed up the shafts. The depth, or thickness of the ground, from the open air to the roof of the tunnel, varies from five to seventy feet, at different parts of its length. The tunnel is sufficiently lighted by gas-burners, which are placed at distances of twenty-five yards asunder, through its whole extent; the white-washed sides and roof serving to reflect and increase the light. The tunnel occupied two years in completing, and cost £34,791.

The tunnels belonging to the London and Birmingham, and other railways, either completed, in progress, or in contemplation, we need not particularize here; since they are sufficiently analogous to the one which we have described, to render distinct and separate description unnecessary.

But we now come to one which eclipses them all in the gigantic power of the difficulties to be contended with. However hard a rock, or however soft a soil, excavators may have to pass through, in an ordinary tunnel, they are free from the embarrassing difficulties inseparable from the existence of a large river over the excavation. These difficulties, which Mr. Brunel, the engineer, and the workmen under his direction, have, for some years, braved with an unconquerable spirit, demand a somewhat detailed notice from us.—We, of course, are alluding to the "Thames tunnel."

The communication between the shores of Middlesex and Surrey, are kept up, at London, by means of the numerous bridges which cross the Thames. The bridges of London, Southwark, Blackfriars, Waterloo, Westminster, and Vauxhall, serve as media from one shore to another. But the great manufacturing and commercial establishments below London bridge have no medium of communication across the river, but by a circuitous route by way of London bridge. A bridge, in those parts, would be too gigantic an undertaking; for it would be necessary that the arch or arches should be lofty enough to allow regular *ships* to pass beneath them. It was, therefore, many years ago, the object of attention, among engineers and commercial men, to determine how far it would be practicable to construct a road under the Thames, instead of a bridge over it, in these parts. The accompanying engrav-



ing will illustrate the advantages proposed to be attained by the construction of some mode of communication between the opposite shores of the river, at some spot eastward of London bridge, and westward of Greenwich. The figure is a slight map of the Thames, at that part. Suppose a wagon-load of merchandise had to be removed to the neighbourhood of the London Docks, from the opposite side of the river! A glance will show how great must be the loss of space by passing over London bridge, the most eastern bridge over the Thames. The map represents the exact position suggested for the excavation of a tunnel.

The first attempt of this kind was so low down the river as Gravesend. But this plan was looked upon as too chimerical, and was speedily abandoned. In 1804, another plan was proposed, for cutting a road-way under the Thames, from Rotherhithe to Wapping, nearly on the spot occupied by the present tunnel. A shaft was dug on the Rotherhithe side, to a great depth; and from thence a small channel, called a *drift*, was cut through the soil under the Thames, in a horizontal direction. This was continued a great part of the way towards the Middlesex side, when the occurrence of land-springs, and other obstacles, led to the abandonment of the enterprise; for the prevalent opinion seems to have resolved itself into the following question,—if we encounter so many difficulties in the construction of a small drift passage, what will be the obstacles to the progress of an excavation sufficiently capacious for the purposes of traffic?

For nineteen years from this period, various plans were proposed, and estimates given, for the construction of a tunnel under the Thames; but, until the year 1823, nothing occurred to give a stamp of practicability to any of them. But in the last-mentioned year, Mr. Brunel issued proposals, plans, and estimates, for a tunnel to be made at once;—that is, the whole of the necessary height and width to be excavated at one time, instead of first making a drift, and then enlarging to the proper dimensions. This plan was looked upon as being worthy of support; and a company, supported by joint-stock shares, was formed to carry it into execution. Borings were made in the bed of the river, in three different lines, in order to determine the nature of the soil through which the tunnel was proposed to be carried.

Operations were commenced on the Rotherhithe shore, at a spot distant about two miles from London Bridge. As the tunnel would, of necessity, have to be carried far beneath the bed of the river, for the sake of safety, it is obvious that it would likewise be far below the level of the ground. How, then, was that to be made available as a road for traffic? How were wagons and carts to get down to the tunnel? To effect this it was proposed, that there should be an inclined road, having a gentle declivity, leading down from the surface of the ground to the level of the tunnel. This line would either be in a straight or in a curved direction; and two reasons induced the choice of the latter. A straight road, proceeding from a depth of fifty or sixty feet, and of so gentle an acclivity as not to distress horses when drawing a vehicle up it, must necessarily extend to a great distance, and require the purchase of much land; and it would, at the same time, carry the point of emergence too far away from the wharfs and manufactories near the water's edge, for whose accommodation the tunnel was in a great measure projected.

The carriage-way leading from the ground to the tunnel was, therefore, planned in the form of a spiral, two hundred and fifty feet in diameter, round which the road was to wind. This was to be the carriage-entrance. This spiral road-way may be seen by referring again to the map. On the London side, a new road was to be cut from Ratcliff-highway, which, passing by the London Docks, should communicate with the Thames Tunnel by the descending spiral road noticed in the map. At the Rotherhithe side, a similar spiral road-way connects the tunnel with a commodious road, to be cleared and perfected for that purpose. The entrance for foot-passengers was planned to be a winding staircase round the inside of a cylinder or shaft, which was to be sunk close to the end of the tunnel. These shafts are represented by the two white circular openings in the map, between either end of the tunnel and its adjoining spiral road.

In order to give an idea of the magnitude and nature of the undertaking, we will proceed to describe it in its present state, or at least, as it was when we visited it at the commencement of the present year.

After wading through a chaos of mud and bustle, we reached the Rotherhithe entrance, and proceeded at once to the upper part of the shaft. This shaft, instead of displaying an elegant and well-lighted staircase, which it will eventually do, contains through its centre, from top to bottom, a huge frame-work, holding machinery for drawing up the earth, mud, and water, which the excavators meet with in their progress. At the bottom of the shaft is a reservoir fifteen feet deep, into which the water, which flows into the tunnel from the numerous land springs while the men are digging, is conveyed, and from which it is afterwards pumped up to the surface.

At the bottom of the shaft we see the outline of an arch, which is hereafter to be broken through, and to form the commencement of the spiral carriage-road. Opposite to that, we see the entrance to the tunnel, the appearance of which we cannot better describe than by comparing it with Burlington Arcade; excepting that the Thames Tunnel consists of two archways or roads, and Burlington Arcade has but one.

The shaft was introduced into its present position in a remarkable manner, considering its great bulk. It is a cylinder of substantial brickwork forty-two feet in height, fifty feet in diameter, and three feet thick. It was built on the surface of the ground, and then the earth beneath it was gradually dug away, so as to lower the brick shaft into its place. This was done until they had passed through a gravelly soil, and had reached a stiff blue clay, favourable to the progress of the miners.

The operations on the Middlesex side are not yet commenced; but there will be a shaft on that side exactly resembling the one on the Rotherhithe side of the river, and the distance between the two will be about thirteen hundred feet, which is thus divided:—one hundred and fifty feet from the Rotherhithe shaft, to low-water mark, on that side of the river; seven hundred and seventy feet, width of the river at low water, and three hundred and eighty feet from the shaft at Wapping to the low-water mark, on that side of the river. Of this distance there is now done about eight hundred and fifty feet, and seventy more will bring it to the level of low-water mark, on the Middlesex side.

The form of each of the two arches into which the section of the tunnel is divided, is as nearly as possible that of a horse-shoe. The whole height of the opening excavated is about twenty-two feet, and the whole breadth thirty-eight feet. These dimensions are reduced by several processes:—first, a substantial lining of bricks, of a great thickness, covers the surface of the whole excavation. Secondly, a solid brick wall is built through the centre of the channel, as a support and strengthener. Thirdly, part of the curvature at the bottom is filled up to afford a flat road-way and pavement for traffic. By these means this great excavation is reduced to two roadways, separated from each other by solid brickwork, and each one furnishing a road sufficiently broad for any common vehicle, and a pavement for foot-passengers. The vehicles going from north to south will pass along one avenue, and those going from south to north will pass along the other. It may, also, hereafter prove convenient for foot-passengers to adopt the same plan, by which they would not jostle against one another, for the foot-pavement is rather narrow; still they have the means of passing from the footpath in one avenue to that in the other, by means of lateral openings through the central brick division, which openings occur at the distance of every few feet. Gas-lights are placed in these lateral openings, in such situations as to afford a pleasant and sufficient light to the whole tunnel; for it need hardly be said, that as it is more than sixty feet below ground, the natural light of day is wholy shut out.

The gradual deepening of the bed of the river towards the middle, rendered it necessary that the tunnel should also descend from the shaft towards the centre.

This obliquity is about two or two and a quarter feet to every hundred feet, and is not such as to fatigue horses travelling on such a road-way. The Middlesex end will probably have a similar declivity, so as to present the greatest depression near the middle of the tunnel's length.

When circumstances, to which we shall presently allude more particularly, rendered it desirable that the Thames Tunnel, so far as it was then finished, should take its stand among the public exhibitions of London, one of the two archways was cleared of all working implements and obstructions; the brick work was nicely stuccoed; the gas-burners were fitted up properly; and the ground, or future carriage and foot-paths, were neatly gravelled; a temporary staircase was made down the shaft, separate from that by which the workmen ascended and descended; and all was made as comfortable as could be expected for the reception of visiters, without interrupting the progress of the workmen. From 20,000 to 40,000 persons have visited it every year since it has been thus opened to the public; and although the funds thus produced have not been large in amount, they have served to show the interest with which this remarkable undertaking has been regarded. It is not always that the inhabitants of a country are themselves the best judges of the merit or attraction of any public work which may be carried on in it. Although the admiration which the Thames Tunnel has excited, and we think always will excite, among our own countrymen is great, this admiration is not so vivid as that which it has excited among foreigners. There are many remarkable instances of the impression which the sight or the reputation of this public work has made. Miss Pardoe, in her *City of the Sultan*, states, that she was surprised while at Constantinople, at being asked by an Albanian chief respecting the progress and the probable success of the Thames Tunnel! Such a question must have brought "Father-land" back to the memory of one sojourning in a foreign country; and we may imagine the pleasure with which that lady answered a question so likely to gratify her national feelings. The present enterprising Pasha of

Egypt, likewise, is known to feel a strong interest in the success of this undertaking. His possession of the comparatively narrow belt of land which separates the Red Sea from the Mediterranean, and through those, the Indian Ocean from the Atlantic; the attempt which he is making to raise the commercial importance of Egypt; and his acknowledged sagacity; make him view with interest the progress towards completion of an undertaking, which may serve him as a valuable pattern from which to copy, when occasion offers.

We have said that only one out of the avenues was opened to visiters; so it remains up to the present time; and so it is likely to continue until the whole is completed. The other avenue is appropriated to the workmen who pass and repass to and from their work at the blank end; and likewise to the conveyance of the materials employed by the workmen. It also serves as the channel for conveying away the earth which the miners dig out in their progress. This earth is thrown into boxes, or small carts, and drawn along a rail-way to the bottom of the Rotherhithe shaft, up which it is lifted, and then emptied out at the surface of the ground. The water which may ooze through into the tunnel from the numerous land-springs which the miners meet with, flows through a pipe from one end to the other end of the tunnel, falls into the reservoir or tank at the bottom of the shaft, and is from thence pumped out by the force of a steam-engine.

When we speak of miners digging the earth away to form the tunnel, let not the reader think that the men stand before a blank surface of earth, and cut with their pickaxes and shovels as they would do in a gravel pit! Vast, indeed, are the arrangements before a single shovel-full of earth is removed from the ground in front of the miner. The reason for this may be soon told. When a great body of water, such as the Thames, flows over a cavity, such as the Tunnel, every crevice or chasm which may happen to exist in the bed of the river becomes a channel whereby water is conveyed into the excavation, or into its immediate neighbourhood. Besides the Thames water, there are innumerable land-springs pervading the soil in every direction, which not only form small streamlets, but moisten, and turn into a sort of mud, the soil through which they move.

Now, if the miners were to proceed in excavating a cavity, the sectional area of which is upwards of eight hundred feet, (thirty-eight feet by twenty-two and a-half,) the upper soil in front of such a great opening, subject as it is to so great a pressure from above, would burst in, and allow a flow of water into the excavated tunnel. The aim, therefore, must be, to board up, or otherwise secure, the greater part of the face of the soil, while small portions, only, of it are being dug away.

This is effected by means of a most ponderous and intricate piece of mechanism called the *shield*. This is wholly the invention of Mr. Brunel, the engineer of the tunnel, and is a very remarkable piece of mechanism, consisting of not less than five thousand separate pieces, all of which act towards one common object. The vertical face of the soil about to be excavated is closely boarded up, by means of planks separate from one another, and capable of being pressed up against the soil with great force. Some of these boards, which are called *poling boards*, are removed in order to let the pickaxes of the workmen excavate beyond them to the extent of a few inches; while the remaining boards are left close. These latter are then removed, one by one, and the excavation made beyond them in the same manner.

In order to afford room for a number of miners to work at once, a large frame is built up, the whole height and width of the excavation, and about eight feet deep. This frame is divided vertically into twelve spaces, every one of which is separate and distinct from the others, but placed in close contact to the adjoining ones. Each of these spaces is sub-divided horizontally into three cells, one above another, the size of the cells being about six feet high and three feet wide. There are thus thirty-six cells in all, and each cell is a sort of little workshop for a miner; so that thirty-six miners can be working simultaneously. This arrangement is represented at the foot of the present chapter, which is a front view of the shield, with its thirty-six compartments, every one of which contains a miner proceeding with the excavation.

The general mode of working is to excavate about nine inches in depth over the whole surface of the vertical face of earth, and then to move the shield onwards to that extent. Each division is moved separately. It is supported on two feet, which, by an ingenious contrivance, are thrust onwards, and the cells above them are then likewise urged forward. Six alternate divisions are moved forwards; and then the other six. When the whole have been advanced as many inches forwards as the excavation has proceeded, the bricklayers immediately succeed the miners, and cover with brickwork the belt of earth which has been laid bare by the advance of the shield. By this means the tunnel is not left for a single day exposed to the mercy of earth and soil alone: as soon as ever there is room enough—nine inches—to admit another layer or course of bricks, the bricklayers proceed to work and give stability to that which the miners have left behind them. The brickwork is of the most substantial and excellent kind, and immediately forms a coat which protects the tunnel from the action of the earth and water above it.

During this period, we are told, the men worked night and day, being divided into three parties, which relieved each other every eight hours. Good wages were paid; and hence the engineer was enabled to command the services of first-rate bricklayers in the process of bricking and cementing after the miners. The men were not required to perform task-work: all that was required was, that they should keep steadily at the work, and lay the bricks in a careful and workmanlike manner. The best cement was used, and such as would harden very quickly. Within two hours after any bricklaying, the work was carefully tested. An overseer went round with a hammer of fourteen pounds weight, with which each separate brick was struck a hard blow. The bricks themselves were always carefully chosen and approved, before being brought into the tunnel for use. If at the overseer's blow, the cement yielded, so as to disclose the smallest opening between the bricks, the workman was immediately called back to repair the defect, and likewise fined one shilling to the sick-fund. If the brick shook in its place upon being struck, nothing but a special plea in excuse could save the workman from instant dismissal.

We have described briefly what the tunnel is, and what it is intended to be; but we have said nothing of the trials, the difficulties, the "hopes deferred," and of the indomitable perseverance which has so far triumphed over them. To form great but practicable plans is one of the characteristics of genius and sagacity; but a firmness to bear up against obstacles and difficulties, and an inventive faculty to devise means for their removal, are powers which are scarcely, if anything, less important. The whole of these powers have been required by the engineer, Mr. Brunel, during the progress of the works, and have been manifested by him. For fifteen years he had to struggle against difficulties, such as few of our great public works have occasioned.

In 1823 Mr. Brunel first issued his proposals for the tunnel. By midsummer of the following year, a company had been formed, an Act of Parliament had been obtained, borings had been made to ascertain the nature of the soil, and the excavation was commenced. First, the enormous brick shaft, which was before described, was built, and sunk into the earth to the requisite depth. Then the horizontal cutting commenced, at a depth of sixty-three feet below the level of the ground.

The erection and sinking of the shaft, the preparation and fixing of the shield, and other labours, occupied the whole of the year 1825. By new year's day of the following year, the shield was ready to receive its band of thirty-six miners, and the horizontal digging commenced, through a stratum of stiff blue clay. All went on well till the 25th of the same month, when, instead of a firm compact clay, the miners encountered a loose gravelly soil, full of land-springs. This was a serious retardation, owing to the quantity of water which thus flowed into the excavation. But the work proceeded steadily, although more slowly, and by midsummer they had reached the level of low-water mark on the Rotherhithe side.

For nine months all went on pretty well, and by the end of April, 1827, the tunnel had advanced 400 feet below low-water mark, or 550 feet from the shaft at Rotherhithe. But the soil now gave evident symptoms of being in a loose, crumbly state, and incessant precautions were necessary to guard against danger. On the 18th of May, several circumstances had occurred to increase the disturbance of the soil in the immediate neighbourhood of the shield, when the water suddenly formed a chasm through the bed of the river, and rushed into the tunnel at the small earthen space between the brickwork already finished, and the shield. The workmen, by a precipitate retreat, were enabled to effect their escape.

Now was a trying moment for the engineer. His tunnel was filled with water, and the progress of the work stopped. Pumping was of no utility, for the water would have flowed into the chasm as fast as it was pumped out at the shaft. The first object was, therefore, to fill up the chasm which the water had made in the bed of the river. This was effected by throwing out, from barges moored over the spot, enormous quantities of clay, contained in bags. These bags were precipitated into the chasm, which they completely filled up, and were then allowed to settle and consolidate into one mass. A kind of raft was then made, and lowered to the bed of the river. The object of this raft was to protect the clay which had been just thrown in, from the action of the tide as it flowed each way.

When the chasm, which opened a communication between the tunnel and the water in the river was thus completely filled up, preparations were made for clearing the tunnel again, and resuming operations. All the water was pumped out; and it was found that the brick-work and the shield were so admirably constructed, that neither had received any serious injury. After a short time the miners resumed their labours, and by the end of the year fifty feet more had been completed.

But now approached the period of a more awful calamity than the former. By the beginning of January, 1828, many symptoms of a disturbed and loose state of the soil occurred. The miners had even to cut through a number of feet of the bags of clay which had been thrown into the river to fill up the former chasm, so much had the bed of the river been disturbed by the irruption, which had rendered that supply of clay necessary. The raft at the bottom of the river became loosened from its place, and floated to the surface, leaving the soft soil beneath exposed to the action of the tide. These and other circumstances rendered the state of the ground in the vicinity of the shield so dangerous, that, by the 12th of January, it was evident a second irruption would occur. Mr. Brunel was in the tunnel, and ordered every one out of it, except three men whom he retained near him. His efforts to stem the approaching calamity were in vain; the waters burst in and swept him along the whole length of the tunnel, and allowed him to escape up the shaft. The other three men were less fortunate: they became entangled in the dark terrors of the tunnel, and met with a watery grave, as sudden as it was fearful!

Again the necessity of ceasing the operations occurred; again it became imperative to throw an enormous quantity of clay into the chasm which the irruptive water had made in the bed of the river. When we say that seven thousand tons' weight of clay was thrown into the two chasms, occasioned by these irruptions, it will serve to convey some idea of the immense size of the breaches made in the bed of the river.

The water was removed from the tunnel, the brickwork was uninjured, and engineers and men were ready to resume their labours. But here, one of those obstacles occurred, which is more potent than even the natural difficulties of land and water in these matters. The funds of the company were exhausted. A sum had been raised, as the joint stock of the company, in accordance with the estimate which the engineer had given of the probable outlay. But a large portion of that fund had to be devoted to the reparation of the numerous unforeseen difficulties which marked the progress of the works, and before the tunnel had proceeded to half its required length, the funds were exhausted.

For the long and weary period of six years and a-half, the engineer had to suspend the prosecution of an enterprise on which so much of his talent and perseverance had been bestowed. The first attempt to raise a fund for the completion of the work, was the power granted to the company, by Act of Parliament, to raise a loan to the amount of 200,000*l.*, which it was considered would be more than sufficient to complete the undertaking. But this attempt failed; subscribers to the loan were too few and too tardy to meet the inevitable demands consequent upon the resumption of the works. The reason for this may be easily surmised. Those who invest their money in joint-stock undertakings, do so with the hope of gaining a larger interest for it than can be obtained in the public funds; and if the speculation into which they propose to embark, seem to show but doubtful symptoms of success, nothing more is wanting to make them hold back. So it was with the Thames Tunnel. Repeated disasters had occurred, and had engendered doubts and misgivings, the result of which was, that the project for a loan failed of success.

It was next proposed that a private subscription should be raised; but this, although supported in a very creditable manner, naturally failed in producing a sum sufficiently large for the objects required.

The only course now was an application to Government for the advance of the necessary supplies from the national exchequer. Such proceedings are always slow in their progress; and although there was a general feeling in favour of the project, it was not till June, 1834, that the Government finally agreed to advance 250,000*l.* in portions from time to time.

Attention was now once more directed to the almost-deserted tunnel. The old shield, which had become too much injured for further use, was replaced by a new one, still more elaborate and ponderous than the former, in order that it might be the better able to contend against the difficulties which experience had shown it would be liable to encounter; as, for instance, the pressure upon it from above was often as much as 300 tons. Many months were taken up in these preliminary preparations; and it was the beginning of 1836 before the tunnelling was resumed in earnest.

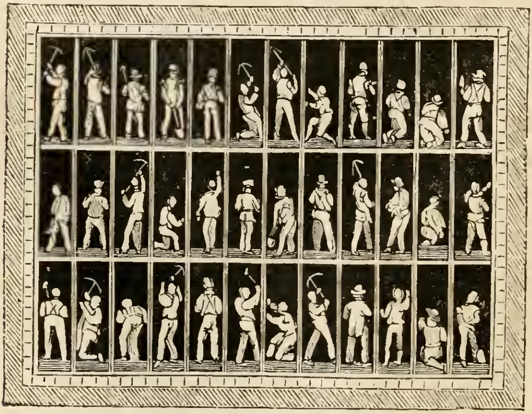
Forty feet were excavated in the next six months, and from that time to April, 1837, ninety-six feet more were completed, making in the whole 736 feet, the average rate of progress since the resumption of the works being about two feet and a-half per week. For some time after this the rate of progress has not been so much as one foot and a-half per week, so much were the engineer and directors harassed by the constant occurrence of land-springs, irruptions of a minor character, and temporary stoppages for want of further advances from Government. The progress at the time we are writing is more favourable than it has been for a long period, being at the rate of three feet per week. Sixty feet more will bring the excavators to the level of low-water mark on the Middlesex side, after which the difficulties will in all probability greatly diminish, as they will then have to proceed under the dry land, except the small distance due to the high water level.

When Mr. Walker surveyed the tunnel, by order of Government, in April, 1837, he named two years and a half as the shortest time in which it could be completed. That would bring the period to the latter end of the present year (1839); but it is evident that the completion, from the numerous difficulties which have occurred, will be delayed much beyond that period. In August, 1837, another, but less formidable, irruption occurred, the effects of which it took some weeks to get clear of. It seems probable that the whole expense, provided no more irruptions take place, will be somewhere about 400,000*l*.

In order to give an idea of the relative distance from the surface and from the bed of the river to the tunnel, a representation of the vertical section of the tunnel through its whole length across the river is given at the head of the present chapter. The tunnel, it will be seen, is not quite horizontal, but is rather depressed under the middle of the river. The row of archways shows the lateral openings from one roadway to the other. At each end is seen a shaft, continued from a considerable distance above ground to several feet below the tunnel. The lower part is the reservoir, in which the water flows which may enter the tunnel during the progress of the excavation. Round the part of the shaft above the reservoir is seen the spiral staircase, by which foot-passengers descend to, or ascend from, the tunnel. The extreme ends show the commencement of the spiral carriage-ways, which want of room prevents us from introducing in our engraving.

We cannot withhold the expression of our earnest desire that this most creditable specimen of engineering skill may be brought to a satisfactory conclusion. It will then take its place with the Menai bridge of Telford, the Eddystone lighthouse of Smeaton, the Waterloo bridge of Rennie, and the Grand Trunk Navigation of Brindley, as honourable specimens of the skill and enterprise developed in this country, and applied to the furtherance of its commercial transactions.

It was stated in a Paris paper, a few years ago, that a tunnel was about to be made under the Vistula, a river running through Poland and Prussia, which tunnel should be "somewhat similar in design and in purpose to the Thames tunnel." We are not at present aware whether it has been put into execution.



Shield in which the Men work in the Thames Tunnel.

Military Road upon the Wall of China

CHAPTER XI.

On Military Walls and Roads.—China.—Military and common Roads distinguished.—Military Roads of Scotland.

In the ancient state of the military art, both cities and large tracts of territory were often defended by means of walls of prodigious length, height, and thickness, upon the tops of which were military roads of sufficient breadth and solidity for the passage of men, horses, and chariots. Of this description of military road, as well as of ancient roads in general, the specimen at once the most ancient, and the most complete in actual preservation, is perhaps that which runs along the top of the Great Wall of China, a view of part of which extraordinary structure stands at the head of this chapter. The building of that wall is dated at two thousand years ago. It is the work of the first Emperor of the Chinese dynasty of Tzin. It runs along the northern frontier of China, which country it separates from Independent Tartary; and its original purpose was that of defending the Chinese against all Tartar molestation. That purpose it answered for the first fourteen hundred years of its existence; but soon after the termination of this period, (in the year 1212,) a Tartar leader, with his followers, succeeded in forcing the barriers of the wall, in effecting the conquest which the wall was intended to prevent, and in placing Tartar conquerors upon the Chinese throne, of which they have been masters ever since. Still, the wall is a defence of more or less strength against all new Tartarian enterprise; and hence the Tartar Emperors of China, now settled upon its Chinese side, have been as careful to preserve it as anciently the Chinese Emperors themselves were industrious in building and defending it. The accounts of Parish and Staunton enable us to describe this wall somewhat minutely.

This wall commences at the eastern end, at the shore of the Gulf of Pechele, $3\frac{1}{2}°$ E. of Pekin, and terminates at its western end at Syning, 15° W. of Pekin, after traversing the extraordinary distance of fifteen hundred miles.

Sir George Staunton, alluding to the first view of the wall, says, " What the eye could, from a single spot, embrace of those fortified walls, carried along the ridges of hills, over the tops of the highest mountains, descending into the deepest valleys, crossing upon arches over rivers, and doubled and trebled in many parts, to take in important passes, and interspersed with towers or massy bastions at almost every hundred yards, as far as the sight could reach, presented to the mind an undertaking of stupendous magnitude." In one place the wall is carried over a ridge five thousand two hundred and twenty-five feet high. The body of the wall is composed chiefly of earth, flanked on each side by a wall of brick, and covered by a platform or terrace of square bricks. The walls, continued upwards to some height, form the parapets. The height of brick-work averages about twenty-five feet, of which the parapet occupies five. The brick flanking walls are supported by stone-masonry underneath; and the thickness of the brick-work diminishes from five feet at the bottom, to one foot six inches at the top.

The entire thickness of the wall, including the earth-work enclosed between the brick-walls, is twenty-five feet at the bottom, and about fifteen at the top, the earth-work being of equal thickness throughout.

Towers are placed at distances of one hundred yards from one another along the wall. These towers are not all of equal size, but vary according to the strength necessary for the part where they are placed. One which Captain Parish measured was thirty-seven feet high from the ground, about forty feet square at the base, and thirty at the summit; and it projected eighteen feet beyond the wall on the Tartary side.

Another tower contained two stories, one above another, and was built with amazing strength. It was forty-eight feet high, forty-two square at the base, and thirty-six at the top.

There are loop-holes along both edges of the wall, for the use of weapons against an approaching enemy. Captain Parish observes: "The great wall does not appear to have been intended as a defence against cannon, since the parapets are insufficient to resist the force of cannon-shot. But the soles of the embrasures of the towers were observed to have been pierced with small holes, similar to those used in Europe for the reception of the swivels of wall-pieces. The holes appear to be part of the original construction of the wall; and it seems difficult to assign them any other purpose than that of resistance to the recoil of fire-arms. The field-pieces seen in China are generally mounted with swivels, for which these holes are well calculated; and though the parapets are not capable of resisting cannon-shot, they are sufficiently strong to withstand these small pieces. From these considerations, it does not seem unlikely that the claim of the Chinese to a very early knowledge of the effects of gunpowder, is not without foundation."

The bricks, of which the wall consists, are about fifteen inches long, seven and a half broad, and three and three quarters thick. Those which form the flat terrace or platform are about fifteen inches square. These bricks are of a blue colour, a circumstance which has led to a doubt whether they had ever been exposed to any greater heat than that of the sun. But kilns have been discovered near the wall, where it is probable the bricks were burned; and it has been subsequently proved by Dr. Abel, that the clay of which the bricks are made, which is red in its original state, becomes blue by burning.

The wall is not absolutely continuous from one end to the other, as it is crossed by a ridge of lofty mountains near Suen-hao, and is likewise crossed twice by the great river Whang-ho. The former obstruction is too lofty, and the latter too broad, to suffer the wall to be continued at those parts. The wall is stated to be a mere mound of earth at its western end; and it was, perhaps, never quite finished in that quarter. The immense mass of matter which the whole wall contains is such, that a calculation has been made, by which it appears that the materials, supposing it were a solid mass of masonry, would be sufficient to surround the earth on two of its great circles, with a wall six feet high, and two thick.

The Chinese historians say that the wall was begun and completed in the short space of five years, every third man in the empire being forced to engage upon it. But it is supposed by modern writers, that it must have been the work, not of one, but of several successive princes.

Among the Anglo-Saxons the term *military*-road was equivalent to *Roman*-road; because the roads constructed by the Romans in Britain were intended for military purposes. An old writer on the subject thus draws a distinction between military and other roads:—"Some ways are military; others not. Those are military where we travel with the army and baggage. Therefore, it behoves a military way not to be much more spacious than military machines. The ancients laid it down as a rule, that they should be never less than eight cubits. By the law of the twelve tables they thus fix the road, that when it is straight, it should be twelve feet broad, when crooked, sixteen. The non-military roads are those by which we go out of a military road into a village, or town, or into another military road. It is necessary that the course of military ways should not be the same through the country, as through the city. Without the city, these things especially are to be observed:—that the road be wide, and most open for looking round everywhere; that it be free and most clear from every incumbrance of waters and rains; that no lurking-holes, no recesses be left for robbers to lie in ambush; that no adits convenient for devastation lie open to it. Some think a couutry the safest where deep roads, like sunk ditches, intersect the country, ambiguous in the entrance, uncertain in the progress, and by no means safe, with high banks, from which an enemy may be easily crushed; more skilful persons prefer the safest road, that which is carried along the level ridge of eminences."

During the rebellion in Scotland in 1715, the expediency of rendering accessible the fastnesses of the North became apparent to Government as a measure of national police. At that time the royal troops were unable to penetrate beyond Blair in Athol; but in the year 1725, General Wade was appointed by King George the First, to draw up a report of the state of the Highlands of Scotland, from personal observation, in order that such measures might be taken as might seem most conducive to the bettering of the country generally. Among other topics, General Wade had occasion to allude to the state of the roads and paths in the Highlands.

He says, "Before I conclude this report, I presume to observe to your Majesty the great disadvantage which regular troops are under, when they engage with those who inhabit mountainous situations. The Savennes, in France, the Catalons, in Spain, have, in all times, been instances of this truth. The Highlands, in Scotland, are still more impracticable, from the want of roads and bridges, and from the excessive rains that almost continually fall in those parts; which by nature and constant use becomes habitual to the natives, but very difficultly supported by the regular troops; they are unacquainted with the passages by which the mountains are traversed, exposed to frequent ambuscades, and shot from the tops of the hills, which they return without effect, as it happened at the affair of Glensheal."

This report received immediate attention, and about the year 1732, General Wade was appointed, with the several regiments under his command in the Highlands, to make certain roads, which should in future be sufficient for the conveyance of troops and military stores. The first line of road which they formed was from Stirling, across the Grampians, to Inverness, and from thence along the chain of forts, including Fort George, Fort Augustus, and Fort William, between the East and West seas, by which troops and artillery were carried with facility into into the central Highlands, mainly owing to which the disturbances of 1745 were speedily suppressed. By the year 1785, the military roads, including what has been termed the Galloway road, from Fortpatrick to the river Sark, on the confines of Cumberland, extended to as much as about 788 miles, including 1011 bridges.

"These roads," says Anderson, "were narrow, but rarely provided with parapets or drains; the bridges were high and steep, and the roads were carried over every inequality of surface, in as rectilineal a direction as possible. Many of the old military bridges, however, have stood the severest winter-floods in consequence of their arches being highly pointed, few, and open, and having no breastworks of stone at either end. In some instances the road has been often swept away at their extremities, and their bare gaunt masses left spanning a wide stream, apparently for no useful purpose.

"They were formed by small parties of soldiers, who during the working season received a small increase of pay; each party was under the direction of a master-mason and an overseer, who had his instructions from an officer, called the baggage-master and inspector of roads in North Britain, and who was directly amenable to the commander-in-chief of the forces for Scotland (Wade)."

"These roads were begun," says Pennant, "in 1723, under the directions of General Wade, who, like another Hannibal, forced his way through rocks supposed to have been unconquerable. Many of them hang over the mighty lakes of the country, and formerly afforded no other road to the natives than the paths of sheep or goats, where even the Highlander crawled with difficulty, and kept himself from tumbling into the far subjacent water by clinging to the plants and bushes of the rock. Many of these rocks were too hard to yield to the pickaxe, and the miner was obliged to subdue their obstinacy with gunpowder, and often in places where nature had denied him footing, and where he was forced to begin his labours suspended from above by ropes on the face of the horrible precipice. The bogs and moors had likewise their difficulties to overcome, but all were at length constrained to yield to the perseverance of our troops.

"In some places I observed that, after the manner of the Romans, they left engraven on the rocks the names of the regiment each party belonged to who were employed in these works.

"These roads begin at Dunkeld, are carried on through the noted pass of Killicrankie, by Blair, to Dalnacardoch, Dalwhinie, and over the Coryarich, to Fort Augustus. A branch extends from thence eastward to Inverness, and another westward, over High Bridge, to Fort William. From the last, by Kinloch Leven, over the Black Mountain, by the King's house, to Tyendrum; and from thence, by Glen Urquie, to Inverary, and so along the beautiful boundaries of Loch Lomond to its extremity."

These roads have been so very important in contributing to the present improvement of the Highlands of Scotland, that, although they may be slighted as specimens of good road-making, they are entitled to the highest praise. In the following extract these roads are spoken of too disparagingly, but we nevertheless offer it to our readers as containing the opinions of a modern celebrated topographer.

"The epigram on Marshal Wade is well known*, but we might easily make a Marforio to it, and turn up our eyes at the manner in which the roads are made. If Fingal was a far greater hero, he was unquestionably also a much better road-maker; and really it is somewhat marvellous how the Marshal could have imagined, how he could have adopted, the best of all possible plans, when he formed the heroic determination of pursuing straight lines, and of defying nature and wheel-carriages both, at

* The epigram here referred to is as follows :—

"Oh! had you only seen these roads before they were made,
You'd lift up your hands and bless Marshal Wade!"

one valiant effort of courage and science. His organ of quarter-masteriveness must have been woefully in arrear, for there is not a highland Donald of them all, nay, not even a stot or a quey in the country, that could have selected such a line of march. Up and down, up and down, as the old catch says, it is like sailing in the Bay of Biscay. No sooner up than down, no sooner down than up. No sooner has a horse got into his pace again than he is called on to stop; no sooner is he out of wind than he must begin to trot or gallop; and then the trap at the bottom which receives the wheels at full speed. The traveller, says some sentimental tourist, is penetrated with amazement and gratitude, and so forth, at General Wade's road—the amazement is probable enough. Pennant, who, if he is not very sentimental, is at least the very pink of good-humoured travellers, supposes the General had some valid military reasons for his hobby-horsical system; this is very kind."

After the rebellion in 1745, the government made a military road from Dumbarton Castle to Stirling Castle; another from the bridge of Fruin up the west side of Loch Lomond; and a third from Duchlage, on the west side of Loch Lomond, across the country to the Frith of Clyde. These roads were long kept in repair at the expense of the government, but this support was at length withdrawn; and by degrees the military roads became supported partly by government and partly at the expense of the various counties.

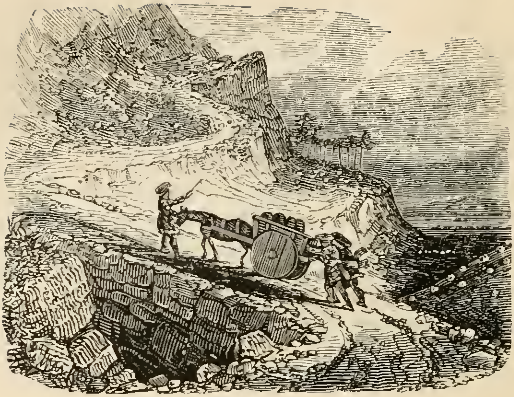
We cannot close this chapter without offering the reader the character of the brave soldier who effected so vast a benefit for the Scottish Highlands.

"On the 14th of March, 1758," says Noble, "died, at the age of seventy-five, the once celebrated and still remembered Marshal Wade, who commanded against the forces of the Pretender in 1715, and having finished the contest, remained in Scotland as commander-in-chief. While holding that office, his soldiers effected the famous military road through the Highlands, which tended more to the civilization of the country than all that the sovereigns before the reign of George I. ever effected. Its inconsiderable expense has caused no less wonder than a just admiration of his incorruptible integrity. He likewise built the noble bridge over the Tay."

It would seem that in the time of the rebellion, about a hundred years ago, the Pretender, with most of his Highland soldiers, escaped in consequence of the badness of the roads on the coast of the Irish Sea, or St. George's Channel, in Lancashire and Cumberland.

"Had the road on the western sea to Scotland been good for the march of an army and artillery, the young Pretender had been overtaken, in spite of all his nimbleness. For the Highlanders, like horses bred in a stony country, might have stumbled on plain ground."

Highland Hut.



Roads in the Scottish Highlands.

CHAPTER XII.

The Scottish Highlands.—Their Roads, Carriages, and Horses.—Roads and Travelling in Scotland generally, in the eighteenth century.—Old Roman Roads.

If roads, travel, and conveyance, were backward, both in the north and south of England, not yet a century ago,—that, at the same period, they were not much better, or that in reality they were still worse, in Scotland, or North Britain, and most of all in the Highlands of Scotland, may easily be thought. Here, in addition to the severity of the climate, and other disadvantages of situation, are mountains, rocks, and torrents to be passed, in the attempt to reach from one place to another; here are but small and often shallow portions of culturable soil; here is poverty, and almost famine, to prey upon the bulk of the population; and hêre, up to the date in question, all improvement, to be expected from neighbourhood to the perpetual increase of wealth in England, was either prevented or retarded, by successive troubles and disorders in the state of Scottish society.

Before the union of Scotland and England under a single sovereign, the borders of both countries were the scenes of mutual and incessant robbery, slaughter, and devastation, between the people of both countries. After the union of the sovereignties, there were internal troubles regarding civil and religious government; and after the parliamentary union under Queen Anne, came the rebellions and discontents which, till the final establishment of the authority of the House of Hanover in Scotland, by the issue of the rebellion of 1745, still opposed themselves to all Scottish advancement in civilization.

The history of roads and travel is intimately joined with civil history in general, and it is needful to advert to certain circumstances of civil history, as well as to the difficulties of surface and of climate, in order to a right view of the sad picture of the Scottish Highlands, some sixty years ago. But the author whom we shall quote, paints the Highlands principally with reference to their winterly aspects and necessities; and produces, therefore, a strong effect of contrast, if his description be compared with the ruddy and sunny drawings of later tourists; tourists who make flying visits; and who make them, too, but in the green season of summer, or to behold the glowing tints of autumn.

We should have been pleased, nevertheless, if we could have added to this preface, that the Scottish Highlands of almost the middle of the nineteenth century are no longer the same countries as almost in the middle of the eighteenth! Vast improvements, to some of which, and to some of their causes, these pages bear evidence, have no doubt marked the inverval, but there still remains too much to be lamented. Climate and surface and situation are still against the natives of the Highlands; and many things remain but as they were.

"An inhabitant of the Highlands of Scotland," says a tourist of the last century, "differs so much from an inhabitant of the Lowlands, in his language, customs, manners, and dress, that to say of either of them that he is a Scotchman, is as indefinite as to say of a native of France, that he is a European.

"The Highlands take up more than one half of

Scotland, and extend from Dumbarton, near the mouth of the Clyde, to the northernmost extremity of Great Britain; a tract which is more than two hundred miles in length, and from fifty to a hundred broad.

"In the country thus defined, one mountain is rudely piled upon another, with vast hollows between them that are filled with snow, especially near the summits, which are frequently higher than the clouds. The ridges generally run from east to west, and, if they are viewed in that direction *, they form the most dreadful prospect that can be conceived. The eye then penetrates far among them, and sees more particularly their stupendous bulk, frightful irregularity, and horrid gloom, which becomes more striking by the shades which they project upon each other, and the pale glimmering light which a faint reflection throws in among them. The summit is generally a naked rock; the surface below is covered with heath; the chasms that are filled with snow appear in white spots; and down the declivity are deep and winding hollows †, worn by the weight and violence of the waters, which frequently loosen and bring down, as they descend, craggy fragments of a prodigious magnitude. Among these scenes of desolation, a few firs and small oaks are sometimes discovered, the root of one being upon a level with the summit of another. Upon a nearer view, some spots of grass are seen among the hollows, but every enormity increases as it is approached; the gloom becomes deeper, the precipice more steep, the bulk of the rude mountains above stupendous, and the hollows of snow, which from the foot appeared no bigger than a table, are found to extend more than a mile. The appearance of these rocks varies with the seasons, and is critically watched by the mountaineers.

* Hence the roads which run north and south follow a surface alternately ascending to great heights, with chasms, and precipices, and beds of torrents, to distinguish them; and descend to great depths, intersected with torrents, streams, cataracts, and broken rocks.

† These winding hollows are the *cleughs* and *cloughs* of the Scotch, and the *gills* of the men of Cumberland and the adjacent northern English counties. *Cleugh* and *clough* are forms of the words *cliff*, *clift*, and *cleft*; and *gill*, or *gull*, is *gully*.

When the uppermost *waters* begin to appear with their white streaks, they say 'the gray mare's tail begins to grow;' and from this time they never venture far from home, lest they should either be swept away by the torrent when it bursts forth, or it should at least cut off their retreat, and leave them in an inaccessible desert, to perish of hunger. One of these mountains, in Lochabar, called Ben Nevis, is of a bulk so prodigious, that it is seven Scotch miles, not to the summit, but to that part only where it begins to be inaccessible!

"Among these mountains there are some flats called *glens*, which their situation renders totally barren; for the hollows in which they lie are sometimes so deep, that the sun is not above their horizon more than three hours in the longest day. *Glen* is also the name given in these countries to a little spot of corn-country, by the side of some small rivulet bounded by hills *.

"In passing this country, it is necessary for the traveller to take provisions, not only for himself, but for his horse, and to procure a guide. As soon as he begins to ascend the first hill, he loses sight of the plain below, and creeps slowly along a rocky valley surrounded with mountains, still hoping that the ridge before him is the summit; and still finding another and another, till he almost despairs of returning again to the level of vegetable nature, or of again beholding the face of a human being. Besides other dangers and inconveniences in this journey, there are several rivers, very deep and rapid. Over some of them, indeed, there is a ferry, but the boat is often so small that the horse is obliged to swim at the stern, and so shattered that the passenger is obliged to stand upon clods of turf, placed over holes in its bottom to stop out the water. When there is no boat, it is best to let the

* The Celtic derivative *glen*, *glynne*, *glin*, *lyn*, or *lin*, has the general sense of "a hollow," either wet or dry, and either perpendicular or horizontal. It is hence a hollow between hills or mountains; a pool or basin containing water, as at the foot of a cataract, &c.; or a bay, hollow, or indentation, in the bank of a coast, lake, or sea; as in the name of the town, port, and bay of Lynn, in Norfolk.

horse choose his own steps, and for the rider to keep his eye fixed upon some object on the opposite side of the river; for if he looks down into the current he will immediately become so giddy as to endanger his seat, to secure which he should at all events let his legs hang in the water wherever the stones at the bottom will permit*. But after all these precautions, the traveller is sometimes swept away by the sudden gushing of water from the rocks above, which no sagacity can foresee, nor any strength resist.

"A mile an hour is the ordinary rate of travelling, the way being sometimes a rough part of the rock, sometimes full of loose stones, and sometimes bog more than two feet deep, with large crags at the bottom. A wood of fir-trees sometimes intervenes, the roots of which, crossing each other, run a long way on the surface of the rock, till they find a cranny, into which they shoot as a hold against the force of the winds above. Among these roots the horse's feet are so entangled, that the bog is scarcely the less eligible of the two. On the summits of the hills, indeed, there are bogs so deep as to bury the horse and his rider. They look like little plains about a hundred and fifty yards square, and the surface is sometimes stiff enough to bear the little Highland horses, which, if they happen to be *bogged*, will lie still till they are relieved; but our English horses, by continual struggling, work themselves so far in, that it is sometimes impossible to get them out.

"In many places the rider is obliged to dismount, sometimes climbing with the assistance of his hands, and sometimes content to slide down the declivity. Some part of the way is a path scarcely two feet wide, on the brink of a precipice. Here the side of the mountain is nearly perpendicular, and at the distance of about a hundred yards below is a lake, into which vast fragments of

* To a rider or driver who is crossing a running stream, the horse or carriage seems to stand still, and only the water to move; and nothing to the inexperienced appears more incomprehensible, and almost incredible, than that after a period of this seeming fixture in the midst of the water, the opposite bank, always growing nearer and nearer, is at length actually reached!

the rock have fallen; and above, the mountain still rises, till its summit is lost in the clouds. In these places the danger is greatly increased by violent and sudden tempests, which scoop the snow from the mountains, and drive it along with incredible force, in such quantities that the rider can scarcely see his horse's head, and the beast himself is driven from side to side by the first fury of the blast; besides, if the snow, which at a certain height falls every day, happens to continue many hours, the face of the country is so changed, that till it melts it is not possible for the best guide to find his way. After such a journey as this, continued, perhaps, for two days, the traveller will suddenly discover a little plain, about a quarter of a mile square, with perhaps, eight or nine little hovels upon it; and this is a Highland town.

"If a drift of snow happens from the mountains, the confinement of the Highlanders to their glens and their hovels is yet more dreary and close than otherwise; for, in this case, the latter are sometimes buried to their roofs, and when it is necessary to open a communication between them, this is effected only by one man beginning at the edge of the drift next to his own dwelling; when, waving his body from side to side, he presses forward, breaking part with his hands, if it is higher than his head. When he reaches the next hut, its inhabitant joins him, and they proceed together to another; and when many have got together, they open, by a similar process, a way for the cattle to return to the huts, the latter being now usually near at hand; because, when drifts happen, the same wind that fills the glens, clears, at the same time, the hills of the snow that is thus drifted, and thus offers to the cattle a free passage from the latter to the former.

"Besides neat cattle, the Highlanders have a breed of dwarf horses, which they call *garrons*, and which run wild among the mountains, till they are eight or ten years old, and are caught in various ways, according to the spots in which they are found. Sometimes they are hunted into a bog; sometimes driven up a steep hill, on which the nearest pursuer endeavours to catch them by the hind legs; and sometimes they are hunted from place to place, till they lie down through mere weariness and want of breath.

"The Highlanders have a tradition that these diminutive horses came originally from Spain, and have dwindled to their present size by degrees. When a bundle is to be carried on horseback, the Highlanders use two baskets, of the kind that in England we call hampers, but which are here called *creels*, of which one is hung upon each side of the little horse; and if the load cannot be divided, they put it all into one creel, and fill the other with stones; so that, for the removal of fifty pounds weight, it becomes necessary for the horse to carry a hundred.

"Where the Highlanders have sufficient depth of ground for ploughing, they plough with four horses abreast; taking hold of the two innermost by their heads, and walking backward themselves, watching the way of the ploughshare, to prevent its striking against the rocks; which, in many places, are to be seen just above the surface. But the soil, even of the corn-lands, is, in some places, so shallow, that, instead of ploughing, they dig it with a wooden spade. The horse, however, is always employed to drag the harrow, which, without harness, is cruelly fastened to the dock of his tail; and, when the tail becomes too short, they lengthen it with twisted sticks."

We are all well acquainted with specimens of these Highland horses, which we know by the name of Shetland ponies; but, how fat, how sleek, and well-fed, and what new lives befal these animals, when they arrive in our southern counties, from the Scottish wilds, either of the mainland, or of the islands still further to the north!

"The stature of the Highlanders," continues our author, "is rather below the standard; especially that of the women, who are, in general, very small. But, though the common Highlanders," he adds, "are squalid and miserable, yet the gentry are a handsome people.

"In these northern parts of Great Britain, the traveller will always find the cattle and the carts diminish in their size, as he leaves the south yet further behind him.

"In the streets of Inverness, the women and maid-servants, in the severest frosts, are seen without either stockings or shoes; and here and there a man dragging along a half-starved horse, scarce bigger than an ass, in a cart, about the size of a wheel-barrow. The load is often not more than might be carried under his arm: but he must not degrade himself by bearing a burden; and perhaps his wife is stooping under twice its weight; for the *women* carry heavy loads, as the pedlars carry their packs.

"Some of these carters have ropes for halters, and harness made of the manes and tails of their horses, which are shorn in the spring for that purpose; but, in general, they make use of birchen twigs twisted and knotted together; and it is from these bands, that they have learned to call all ropes, *woodies*. The collar and crupper are of plaited straw; and, to save the horses back, they put a few old rags under the cart-saddle. The beasts are never either dressed or shod, and it is with great difficulty that they keep their footing, when the carter has occasion to turn the carriage, which he does by taking it up and turning it quite round.

"The wheels are made of three pieces of plank, pinned together at the edge, like the head of a butter-firkin. The axletree turns round with the wheels, which, when they are new, are about a foot and a-half in diameter, but are soon worn very small: and as part of the circumference is *with* the grain, and part *against* it, they wear unequally; and, in a little time, become rather angular than round.

"In summer, when the horse has done his work, the driver attends him while he grazes by the sides of the roads, and the edges of the fields, holding him all the while by a halter, lest he should encroach, for there are no enclosures; and, in winter, many of them are famished to death; and may be seen from day to day crawling along, hanging down their heads, and reeling with weakness till they drop. Hay, indeed, is, even in the Lowlands, a scarce commodity; for, as soon as the grass is cut down, they bring it to town, *green*, for sale; and, at Edinburgh, the place allotted for this traffic, is called the Grass-market."

Descending from the Highlands to the Lowlands we shall find that the roads of the last century, were bad in the extreme. The former modes of communication in Scotland have been treated of, in an able volume, by Mr. Buchanan, who has shown that, although the progress of improvement in Scotland was rather late in its beginning, it has advanced with extraordinary rapidity; and is now keeping pace with her richer neighbour. It is scarcely a century since there was nothing deserving the name of a "road," in any of the great thoroughfares of Scotland; the whole inland trade of the kingdom was carried on by means of pack-horses; and "persons," says he, "are still alive, who remember, perfectly, the carriers between Edinburgh and Glasgow, going regularly with five or six horses in a train; and so narrow was the track, that the leading one had a bell at his head, to give warning of their approach to the party travelling in the opposite direction, that the one might have time to get out of the way, while the other was passing." In this way they jogged along, over all the inequalities of an extremely unequal country, through which the road passed; and fording the different rivers and streams, on which bridges were, as yet, unknown. Carts were then used only in the principal towns, and coaches or carriages rarely in the country; travelling being, almost universally, performed on horseback. The roads, too, were often impassable in low and wet grounds. It is stated that, when Lord Hermand was sent, in 1760, from Ayrshire to the College at Edinburgh, the road was in such a state, that servants were frequently sent forward with poles to sound the depth of the mosses and bogs which lay in their way. Mr. Chambers also states that, when John Earle, of Londoun, was sent, in his youth, to Edinburgh, about the year 1730, he travelled with his baggage in a pair of panniers, across a poney's back; himself in the one pannier, and his baggage in the other.

Some of the Scottish roads were formerly kept in repair by statute-labour, which originated in the early part of the last century. In the fifth year of the reign of George I., an act was passed, which made the following regulations:—

The justices of peace and commissioners of supply, in the several counties, were ordained to assemble at the chief towns in the county, on the third Tuesday in May, in each year; with power to choose clerks, surveyors, and other officers, for the management of the high-roads.

The justices, or their deputies, were empowered to convene the tenants, cotters, and other labouring men, within their district; and to cause them to work on the high-ways, three days before the last of June, and three days after harvest, in each year: this was to continue until the roads were sufficiently repaired.

Any tenant, cotter, or labouring man, who failed to make his appearance, after due notice, and render his quota of the work, was to be fined eighteen pence per day, until he fulfilled his duty, or sent some one else to do it for him.

Up to this time then, and for a good while after, the Scottish roads are represented as being so bad, that they went in straight lines, up one side of a hill, and down another; crossed bogs, which were impassable during winter, and were so badly laid, that that which is now a journey of a few hours, formerly consumed days. Robertson, in his *Rural Recollections*, tells us, that the common carrier from Selkirk to Edinburgh, thirty-eight miles distance, took two weeks for his journey between the two towns, going and returning, The road was, originally, most perilous and fatiguing, owing to the water and the hills. The fellow-townsmen of this individual, on the morning of his going away, took leave of him, as if going upon an undertaking of doubt and danger.

Such alarm did the people of Scotland feel at the first idea of making and improving roads in their country, that the landed gentry, with the farmers and tenants, at the starting of a new road, sought to have it carried as far away from their premises, as possible: but time soon pointed out the error of these foolish views and wishes.

But, bad as the internal communications of Scotland were, they seem to have kept pace with the progress of trade, and general intercourse throughout the country. The mail was regularly despatched between Edinburgh and London, on horse-back, and went in the course of five or six days; but so limited was the communication between the two capitals, that, during the rebellion of 1745, when an order was sent from London to open all the letters in the post-office, with the view of detecting treasonable correspondence, there were not, in all, above twenty letters in the London bag.—"Such," says Mr. Buchanan, "was the low state of trade and business; the true cause of the backward state of the roads, and of all the other accommodations which distinguish a rich and improving country."

Between 1750 and 1760, a coach travelled from London to Edinburgh in *thirteen* days. About the year 1770, roads were so much improved, that carts came into general use, particularly on farms, and in conveying grain to market. With a cart, one horse could draw five or six hundred-weight, while the pack-horse could only carry three. In the year 1790, the construction and management of the roads began to excite great public attention, and improved lines were formed in all parts of the country; which lines were made of better materials; so that, generally, the load of a single cart-horse was increased to eight or ten hundred-weight, and travelling in carriages became very common. Since that period, improvements have advanced with accelerated rapidity, and such have been their effects on the powers of draught, that on almost every public road in Scotland, a single cart-horse can easily draw sixteen hundred-weight; and, on many roads, a stout horse will draw as much as twenty-five hundred-weight. Such has also been the effect of the velocity of motion, that the London mail now performs the journey in forty-three hours and a-half. Between Edinburgh and Glasgow, nearly twenty coaches run daily, and the journey is completed in five hours. The original coach between these two places, which was commenced in 1765, occupied twelve hours on the road; and a swifter vehicle, afterwards introduced, was called *the Fly*, on account of its great velocity,—it went the journey, from Edinburgh to Glasgow, in *ten* hours; a shorter time than had been before occupied in the journey:—but *now* our coaches, as we have just said, complete the distance in half the time!

Before we leave the subject of Scottish roads, we cannot refrain from giving the reader the general information regarding the roads of Caledonia, at the commencement of the Christian era.

The Roman roads in Scotland exhibit the same indefatigable spirit, which distinguished that extraordinary people elsewhere. They built a wall from the Clyde to the Forth, and another from the Tyne to the Solway; and, between these two walls, roads intersected the country in various directions.

The Western-road, as it was called, was the first of these which was constructed. It commenced at the southern wall, near Carlisle, and, crossing Solway-moss, entered, what is now called, SCOTLAND. After proceeding towards the Annan, a branch-road turned to the left, towards Nithsdale. The principal branch proceeded onward to the hilly region, which furnishes the sources of the Clyde, the Annan, and the Tweed, and then went through Clydesdale, towards the river Calder. It afterwards ended at the northern-wall, near the spot now occupied by the city of Glasgow.

The road, called WATLING-STREET, which led through the eastern portion of Scotland, commenced at the southern wall, near Portgate, and entered Scotland near the source of the Coquet. After crossing the rivers Jed and Teviot, it passed near Melrose, and crossed the Tweed. It then passed near Lauder, Oxton, and Bowbridge, at the east end of the Pentland-hills. After passing over one or two more rivers, it joined the east end of the northern-wall at Caeridden.

Laplanders on a Journey.

CHAPTER XIII.

Glances at the modern Roads of Foreign Lands.—Travelling in Lapland.—Roads, and Travelling in Norway—Alpine Roads.—Simplon.—Great Saint-Bernard.—The other Alpine Roads.—Mount Brenner.—Cornice.—Aurelian Road.—Gaspar Stoeri.—Roads of France.

The world which we inhabit offers on its surface greater or less facility for the motions of man. In many cases absolute difficulties present themselves to the traveller; but these are overcome by the exertion of that distinguishing faculty of reason, which enables man to understand the laws which govern the universe, and to apply them to his own purposes. If the waters of the ocean oppose his passage, he constructs ships, avails himself of winds and tides, and floats with ease and rapidity to the land to which business or pleasure calls him; if wind and tide oppose him, he calls to his assistance the wondrous force of steam, and defies both wind and tide: if a gulf yawn at his feet, and seem to forbid his further advance, he throws a bridge over it, and thus continues his road with ease and safety; he passes over the mightiest and most rapid rivers by similar means; and if this cannot be done, he builds a road in spite of danger and difficulty under the very bed of the stream; if hills oppose him he cuts through them; if marshes and bogs threaten to sink under him, he drains them; if his burdens be drawn at too great cost and expense, he constructs canals, and thus lessens his outlay for draught; and if he himself move too sluggishly for his impatient zeal over the rough and uneven ground, he smooths it, and by constructing rail-roads, moves along with renewed velocity.

Man has done all this, and can do still more. His enterprise prompts him perpetually to devise new schemes for facilitating his itinerant wants and wishes. But his power is, to a great extent, limited or modified by the nature of the ground over which he purposes to travel: thus his roads must partake of the diversity of the soil and climate in which they are constructed. Soil and climate, too, are for the most part the powerful means of deciding, or greatly influencing, the manners and customs, the dress, and even the language of nations; hence it naturally follows that the roads and pathways of foreign lands are of a very diverse character: they are made, doubtless, in conformity with the wants of the natives who travel over them, whether on foot or in litters, in open carts and carriages, in chairs fastened to men's backs, on the camel, or on the horse or elephant. The roads are, in short, adapted to the nature of the country, and the beasts of burden found therein, and the carriages are adapted to the roads.

But of carriages we shall speak more hereafter; our present purpose is to bestow a few hasty glances on the roads of *foreign* lands, and to extend the objects for which the second chapter of this book was written.

Let the reader accompany us on an imaginary tour through several foreign lands. We will first take him to Lapland, where we find the ice frequently serving as a road of passage, like the canals of the Dutch, which are cleaved by the boat in the summer, and by the skate in the winter. The beast of draught with the Laplanders is the rein-deer, which, when they have occasion to make an expeditious journey, is yoked to a sledge, which it draws up hill and down dale, with amazing rapidity, over the snow-bound surface of the country. This, in consequence of the frosts, is tolerably level, and furnishes a suitable road. The natives are in the habit of travelling from place to place, and moving their families at the beginning of winter and summer, for the sake of the pasturage, and to mitigate the rigour of the climate. The snow covers the ground for nine months of the year.

We will now pass on into Norway. We select this country for the continuation of our tour, because in it the first good modern roads were constructed. We are too much in the habit of associating the primitive manners of barbarism with these nations of the north: let not the reader fall into this mistake; for we can assure him that, although the proud empire of Rome owed its downfal mainly to the people of the north, yet modern civilization has much to thank them for.

The kingdoms of Sweden and Norway cover a space of 292,700 English square-miles, of which the larger part belongs to Sweden. From the eastern extremity of Sweden to the Norwegian precipices, which overhang the northern ocean, the surface is continually rising; and Norway upon the west of Sweden is, for the most part, to the latter, what the Scottish Highlands are to the Scottish Lowlands, except that the Norwegian heights exceedingly surpass the Scotch. Of the space above-named nearly 4000 square-miles are above the line of perpetual snow; but of these more than three fourths belong to Norway.

The Norwegians, like the Scottish Highlanders, have a small but hardy race of horses, which, heavily laden, go up and down the mountain-roads with an ease that often astonishes strangers. Upon the steep sides of the mountains, and what is worse, upon the smooth sides of the rocks, and among the large and moveable stones, they seem exposed to an incessant danger of falling and breaking their legs. They lead the rude lives of their masters, so that, though the latter are usually kind and considerate, they strike a stranger as enduring both great and needless hardships. They cross, with wonderful success, swift rivers, over which, perhaps, the simple bridges consist only of two coarsely hewn trees, laid down from bank to bank; but where the rider, loosening the bridle freely upon the animal's shoulder, the latter bends its nose to the surface of the logs, and carries the former safely. In other cases (and this may happen at the very end of a hard journey, and when the horse is heated and relaxed from fatigue,) it reaches a river where it has no bridge at all, and the stream of which it must therefore swim; and afterwards remain shivering all night in the open air.

The Norwegian mountains are single, or else in chains or ridges extending many miles from north to south. The ascent to the top of some of these ridges is often as much as thirty-six English miles; and the perpendicular height of the summits, or their elevation above the level of the sea, is computed to be about three English miles. At this height, the air is always as cold as in the depth of winter lower down, and all the waters continue frozen, though exposed to the summer's sun.

The tops of these ridges, which are usually flat and even, are always covered with snow; and the public roads to many places, but particularly to the city of Kongsberg, run over them; yet in travelling them, great caution is required for avoiding the chasms of the numerous cliffs, many of which, in winter, are often concealed by drifted snow, and into which, whoever falls, if he be not killed on the spot, must perish of hunger; except he can find his way out at the foot of the mountain, by some hole which has been made by bird or beast.

Of the single mountains, the elevation is less; but many are from 3000 to 4000 feet in height, with their sides covered with fields and woods, and their feet washed with navigable streams; the summits covered with pasture, and the centres filled with treasures of silver, copper, iron, and other metals.

On these latter mountains are frequently situated the farm-houses and cottages of the peasantry, some of them standing so near to the brinks of precipices that the inhabitants go up to them by means of ladders; and when a clergyman is sent for, he makes his visit at the risk of his life; especially so in winter, when the frost has made the steps or rounds of the ladders slippery. The corpses of the dead, sent forth for burial, are let down by ropes, and then carried upon men's backs to the spots where they can reach their coffins; and at some distance inland from the sea-port town of Berghen, the mail itself is drawn up with ropes, over the steepest of the mountains.

Besides the roads on the flat summits of long ridges of mountains, there are many which run along the sides of the narrow defiles, formed of natural craggy rocks, with huge inaccessible cliffs above them, and impassable wastes, which lie at amazing distances below. Few of these roads, though some of them are the post-roads, are broader than a common path or footway; and many project over the precipice, and are shored up from beneath, to prevent their falling under the weight of the traveller: and in places where the rock has already given way, loose planks are laid over iron bolts driven into the sides of the rock still standing; no part of these fearful passages being secured by rails, it being impossible to fix any.

Norwegian Mountain Road.

A road or passage of this rude kind, but nevertheless a work of art, (for nature had denied any or much assistance here,) is the narrow pass of Naeroe, leading to the river Waas, and constructed by the famous Norwegian king, Suerre, in the year 1200, as a *military road;* that is, as a passage for his army.

Between Scogstadt and Vaug, also, in Volders, there is a road on the side of a lofty and steep mountain, and along the border of a fresh-water lake, so narrow, in many parts, that if two travellers meet, they must either stop short without being able to pass each other, or even to alight; their only expedient being that of one of them catching hold, from his horse's back, of some crag of the mountain, while clinging to which he must push his horse headlong into the lake, and thus make way for the other traveller.

Nor are the narrowness and steepness of these roads the only sources of danger to those who travel them. The clefts and caverns of the rocky mountains are the habitation of innumerable beasts of prey; and bears, and especially wolves, are to be continually expected.

Along these passes, too, and the sides of the mountains over which they lead, it often happens that both goats and black cattle fall into places whence they can neither ascend nor descend; but in these cases, the peasants, accustomed from their birth to the difficulties of the roads, and of the climate, encounter almost any risk for their recovery. A stick being fastened by the middle to the end of a rope, the man puts his legs over it, on each side of the rope, and is let down several hundred fathoms from the top of the precipice, swinging himself to and from the face of the rocks till he can set his foot on the place where his sheep or goat is lodged; when, fastening his rope around it, both he and his prize are drawn up together.

"That men should thus venture," says a native historian, "to descend with no support but a mere rope and stick, from such tremendous heights, and hang over abysses, which a stranger could not behold except with terror, is a strong instance of the force of habit; but that they should aggravate, as is their practice, the dangers they incur, by taking with them but one assistant, is a still stronger; especially as it sometimes happens, that he who holds the end of the rope finds himself unable, not only to draw it up again, but to sustain the weight attached to it. When such extremities, however, arise, this latter has been known, not to quit his hold, but to suffer himself to be dragged down; choosing rather to perish with his friend, than to betray his trust."

In the same daring spirit, the Norwegian *birdmen* are found climbing precipices propped upon a pole, hanging by a cord over cliffs thrice as high as the cross of St. Paul's Church, or scrambling at that height from one crag to another, holding, by one hand, by some craggy prominence, and groping with the other after birds in the crevices of the rock. A restraint upon these excesses by force of law was once attempted, but to no purpose.

If a birdman fell from the rock, and was killed, it was proposed to his next of kin to climb to the same place, by the same way. If he accepted the offer, and succeeded in the task, the deceased was acquitted of presumption; but if he refused, the latter was condemned, as having ventured where it was deemed rashness to repeat the undertaking; and, as a punishment, his body was treated as that of a suicide, being denied Christian burial. The law, however, which was as rude in its provisions as the practices it aimed to remedy, fell early into disuse.

The horses of Norway, like the horses of the Scottish Highlands, are small; but it is otherwise with the Norwegian people. Though fed in a manner that must seem the most impoverishing to an English observer, the Norwegian peasantry are tall, well-proportioned, and of handsome features; or, if they have any defect of personal symmetry, it is because the muscles of their thighs and legs, particularly of the latter, are peculiarly full, a circumstance to be accounted for from the incessant and great activity of their lives on foot. They are of a race quite distinct from the race of Scottish Highlanders.

One living, but more than ordinary, example of this Norwegian strength and stature, as well as of the prevailing goodness of moral character, and of the general toil required for the formation and improvement of the Norwegian roads, is to be found in Eystein Hansen, the distinguished tenant of the farm of Ingolfsland, in the parish of Dal, at a little distance from Lake Tindsjöen.

The roads in Norway are still made and repaired upon the system anciently universal; that is, within a certain distance of the towns, the towns are at the needful expenditure; while, in the country, the inhabitants make and maintain them according to customary allotments, both of space and time.

In Hansen's district, a piece of road, of twenty yards in length, was divided between two peasants; but (on account of the numerous blocks of stone which required to be either broken or removed, and, among others, two of immense size,) those persons considered it beyond the limit of human strength to do the work in less than two days, and refused to undertake it with an allowance of less time. Several other peasants were then applied to, some of the strongest in the neighbourhood inclusive, but all refused the piece of work. Hansen, however, declared that it was no greater task than he could perform alone, and not in two days, but in one; and then, to prove his words, began to work at sun-set, after his neighbours had finished their day's toil, and were gone home. In the first place, he broke into pieces the largest of the two blocks, or "boulder-stones," such as in England are sometimes called "gray-wethers," and cast the latter over the side of the lofty rock, along the ledge of which the road was to be carried; and next, with only the assistance of his crow-bar, he removed the other off the line of road. Completing the job before him, he then dug the level road required, two yards in breadth, one in depth, and twenty in length, and all in the short space of six hours only; besides working cheerfully and equally with his neighbours on the following day. The rock, or "boulder-stone," which he removed, and which still remains a monument below the road, cannot weigh less than two tons.

It gives the crowning-grace, however, to this story, to add that this man, of such extraordinary bodily strength, has been just as much remarked through life for the modesty, gentleness, and unassuming character of his manners; and, that though like a lion when really irritated, his consciousness of his superior force has been often known to make him overlook insults, particularly from strangers, who could not be aware of his powers; and also, as a general principle, to avoid all occasions of quarrel. He is at present growing old, and is an object of general respect with those who know him.

Often, the Norwegian roads are a thousand feet above rivers, lakes, and valleys, which they skirt; but such roads, and even paths that are sometimes frequented more from curiosity than need, are readily traversed by this bold and practised people. To look upon the cataract called the Rikand, and to reach its top, it is required either to go round the mountain Gousta, by a road four English miles in length, or else to ascend by a zig-zag path along its side, to the height of seven or eight hundred feet, and in some places so narrow that the visiter cannot place his two feet by the side of one another, while one false step would cause him to plunge into the gulf beneath. Here, the travellers that are apt to be giddy crawl their way upon their hands and feet; the Norwegian guides at the same time going up and down with swiftness and entire facility.

It takes off, perhaps, somewhat from the merit of that Norwegian tenderness for their diminutive horses, already adverted to, thus to relate the strength, the powers, and the general activity of the men themselves. "Norwegian carriage-drivers," says a recent tourist, "keep up with ease by the side of a carriage at full speed, for ten or twelve miles together. Their consideration for their horses is such, that I never remember seeing them rest themselves behind the carriage, except, perhaps, for a few minutes; and in this way will they continue running to the end of the stage."

A bad posting system prevails in this country, by which the farmers of the way-side are compelled to be ready with horses to serve the wants of travellers. The rate for each horse is only about a penny a mile; the effect of which interference with the rights and property of the people are attended, Mr. Laing says, with manifestly bad results.

But it must not be imagined that in Norway there are no situations adapted for the formation of good roads, or that where good roads are practicable, the Norwegians do not make them. Here, as in Sweden, though both are mountainous countries, there are many good roads at intervals, such as may be easily travelled in a four-wheeled wagon, like that of the Swedish country-people, as seen in the chapter on wheel-carriages. The northern shores of the Baltic sea, which include many of those of Norway, and all of those of Sweden, are as rocky and mountainous as the southern are flat and sandy: from the Baltic to Moscow there is not a single hill.

It is not in Norway, or in Scotland, that the surface of the country gives occasion for the most difficult roads of Europe: for these we must turn our thoughts to the Alps, the most considerable mountains in this division of the globe, and which offer the severest obstructions to travel between the great and populous countries of France, and Germany, and Italy.

Alps is but another word for hills or mountains. The Celtic word *alp*, or *alb*, signifies *high;* and, if applied to land, signifies what, through derivatives from other vocabularies than the Celtic, we call a *high land*, or eminence, or hill, or mountain. Alp, therefore, is, first, a general name for a mountain; and, secondly, and through the accident of ancient local language, traditionally preserved, the Alps (at least with geographers) are those particular mountains in the South of Europe, remarkable alike for their elevation, their extensive range, and the great importance of their position.

The Alps divide France and Germany from the North of Italy, and the North of Italy from the South; and upon the north side of the central and highest part of their range, or chain, is the Swiss Alps (now commonly so called), which comprise the most important places of the Alpine passes, and almost confine to their single share the European celebrity of the Alps.

Over the Alps at the present day there are ten commodious carriage-roads. The roads or passes, taken collectively, and remarkable either for the number of those who travel upon them, the skill and labour of their works, or the beauty of their features or prospects, are twelve in number; and of these the road or pass of Mount St. Bernard, and the great road of the Simplon, are the most celebrated and conspicuous.

"Ten carriage-roads," says an indefatigable explorer and admirable illustrator of the passes of the Alps, "are now completed across the Alps, and others are in the course of formation; and over those barriers, which were once considered impassable without danger, some of the best roads on the globe are at present carried! But the prejudices of nations occupying the two sides of the Alps, as much or more than the difficulties of nature, had required to be conquered, before those works could be accomplished; and that conquest has been achieved only within a few years passed by. It is to these prejudices, or to those fears of danger from the construction of roads, which, overcoming the natural obstacles, opened passes alike for friends and foes, that allusion is made in the recent inscription upon a bridge close to the baths of Pignon, about a league from the Via Mala, and in which is recorded the opening of the new road, begun in the year 1818, and completed in six years, and measuring twenty-six leagues and a half:—

JAM VIA PATET
HOSTIBUS ET AMICIS.
CAVETE RHÆTI!
SIMPLICITAS MORUM
ET UNIO
SERVABUNT AVITAM
LIBERTATEM*."

The Alpine road, called "the road of the Simplon," or that which crosses the alp or mountain of this name, commences in Switzerland, and leads out of the Valais, or

* BROCKEDON'S *Passes of the Alps*. The translation of this inscription is as follows:—

"The way now lies open to friends and enemies. Beware, ye Swiss! Simplicity of manners and union will preserve your ancestral liberty."

valley of the Rhone, into the plain of Lombardy, in Italy, and puts the traveller upon his way to Domo d' Ossola and Milan.

At Martigny, where the valley of the Rhone begins to grow narrow and marshy, and lose itself in the ascent of the mountains, the roads of the Great Bernard and the Simplon take their opposite directions; the one leading westward, to Aosta and Turin, in Piedmont, or the territory of the king of Sardinia, upon the Italian side of the Alps; and the other eastward, and therefore, as was intimated, into Lombardy, or to the cities of Domo d' Ossola and Milan. Around the small but very ancient Swiss city of Sion, the valley spreads again to the breadth of about ten miles, with a fertile soil and beautiful appearance; but a little beyond that city, the road of the Simplon begins to wind up the hill-side. Brig is a small town a very little above its foot; but its important works begin but at a little further still; that is, at the smaller village of Glys.

At this point, a torrent, or rapid mountain-river, called the Saltine, descends from the mountain, through a ravine more remarkable for its size than for any real terrors. Through this broad and retiring vista, the eye is carried upward as far as the gate, or to the summit of the pass. The road proceeds some distance before it joins the ravine, but then skirts its edge for a few miles, and finally turns round its upper end. The distance, in a straight line, from Brig to the head of the ravine, which is at the greatest elevation of the road, cannot much exceed six miles, even if it is so much; but the windings give to the traveller an ascent of thirteen.

Above Brig, the valley of the Rhone is rapidly narrowed; and here the height of the land above the level of the sea is about 2400 feet. From this spot, there is a fine view of a glacier of the Viescherhorn, one of the peaks of the Oberland mountains, nearly opposite to Brig. To the distance of thirteen miles, from Brig to the summit of the road or pass, is to be added five to the village of Simpeln, (the name Simplon in its German form,) and thence to the frontier of Italy, five more. After this, it proceeds to Crevola, on the level of the first Italian plain, at ten miles from the frontier, and then four miles further, to Domo d' Ossola, which is four more; thus giving to the entire route thirty-five miles, of which the last three or four are on a perfect flat.

"It does very well," says the tourist already cited, "to talk, by way of poetical embellishment, about trotting up and down this celebrated pass. But even six horses, attached to the common travelling vehicle, seemed very well disposed to take the matter much more leisurely." There were level portions of the road, he admits, where this trotting was possible, and where, in his own instance, it was actually performed; "but much the greater part of the ascent was made on a walk."

The same traveller "much doubts," whether there is "anything so delightfully horrible" as is usually described, as far as regards the Swiss, or northern side of the mountain. At the head of the ravine called the Ganter, he and his companion alighted, in order to lessen the fatigue of the horses, and walked the rest of the distance to the summit, preceding the carriage the whole way, with great ease to themselves; "a pretty good proof," he insists, "that there was not much trotting! Indeed, the postilions soon after dismounted, walking by the side of their horses most of the time. I do not think, however," he concludes, "it would be necessary to lock the wheels much of the way, in descending; or that it would be at all dangerous to go *down* the whole declivity, on this side of the mountain, at a reasonable trot."

Arriving, next, along the edge of a larger and deeper ravine, or that in which the Saltine flows, he still thinks that the dangers, as well as the recent works, upon the route of the Simplon, (and especially as concerning the ravines of the Ganter and the Saltine,) are described in too florid terms: "Many writers," says he, "speak of the terrific appearance of these two ravines; of trees growing in a line with their sides; of their vast depth, and of the nervousness with which one gazes downwards, into the gloomy abysses. All this struck me as being singularly exaggerated. From Brig to the summit, I did not see a single point where there could have been any great difficulty in constructing a road, or a single spot where a man of ordinary nerves might not stand with great indifference on the extreme edge of the road. The mountain was of vast scale; the road was certainly laid out with great science and method; the ravines, if not frightful, were *yawning*, and of great depth; and there can be no doubt that in many places, torrents, *land-slips*, *avalanches*, and falling rocks, may occasionally do much mischief. One of the latter had done material injury this very summer; but none of these dangers obtrude themselves on the eye of the traveller in ascending. Here and there a small stone 'Refuge' stands by the road-side, a place of shelter in the winter, and during storms. At the head of the ravine, the mountain above it rises more abruptly to a peak, crowned with a *glacier*. As the road is here necessarily cut into the earth, a roof of stone has been built over it, in order to cast the avalanches into the ravine. It is a damp and disagreeable gallery*."

A little below the summit is a toll-house, and at the precise summit a cross; and here the elevation is about 6600 feet above the sea, and four thousand above the town of Brig. "Not far from the cross," continues our tourist, "an *hospice*† is constructing, for the purpose of giving travellers shelter. An old building of the same nature, but of very inferior pretensions, stands in a little valley hard by, deserted and dilapidated. The latter, it would seem, was a private charity; but the new edifice belongs to the brotherhood of the Augustines of the Great Saint Bernard.

"There is little interest in the summit of the Simplon. It has breadth and vastness; but its aspect is that of a rocky mountain-pasturage. The descent to the village of

* It is necessary to observe here, that what in England is called a *tunnel*, has, in France and Italy, the name of *gallery*. In German, and in Germany, it is *hohle*, or hole; and such is the "*Hole* of Uri."

† Literally "an hospital;" but understood only as a house for the temporary lodging of travellers meeting with misfortune upon the road.

Simpeln* is easy, and the distance is near five miles, the whole of which may be said to lie virtually on the summit of the passage; for, though Simpeln is 600 or 700 feet lower than the *hospice*, it is reached before the main descent commences. To sum up the details of the *northern* side of the Simplon, I shall add, that they fell materially short of the grand and terrific effects we anticipated from the descriptions we had not only heard, but read."

In descending the Simplon, upon its southern or Italian side, the same writer still complains of extravagance in the customary descriptions: "We soon reached," says he, "the first of the celebrated *galleries*, which are also features of the route which I think exaggerated. The mere effect of passing through these artificial caverns, amid frowning precipices and foaming torrents, and along a road that, in reality, is as smooth and as safe as a garden-walk, is, beyond doubt, both exciting and strange; but as mere public works, these galleries are neither extraordinary nor unusual. The 'Hole of Uri' is precisely the same thing, and much more ancient, though smaller†. Were the rock entirely blown away, these passes would create much less wonder and conversation, while the labour and cost would have been materially increased. But you can more easily appreciate the labour, if not the effect in a picturesque sense, by learning the dimensions. The longest of these galleries is a little more than 600 feet, the height is about twenty, and the breadth twelve. The single cutting on the Erie Canal near Lockport‡, as a

* That is, the village on the Simpeln, or Simplon. Simpeln is the German form of the name, as Simplon is the French, and Sempione the Italian. The later Romans were well acquainted with this pass, and doubtless they more or less improved it; and some are of opinion that its name must be derived from the Roman name Sempronius.

† The Hole of Uri, as suggested in a preceding note, is what in England would be called a *tunnel*. It is situated in a gorge of the mountains, where the Reuss finds its way out of the valley of the Ursern. The tourist describes it as "a dark gallery, about two hundred feet long, and of ten or twelve in height and breadth."

‡ In the State of New York.

mere public work, materially surpasses all the cuttings and blastings on the Alpine passes put together, although there are now two other roads but little inferior, if any, to this of the Simplon *.

But, here, however, the writer does not omit to subjoin, that "notwithstanding all the mistakes which have arisen from indiscriminating descriptions, poetic feeling, or popular error, no passage of the Alps can possibly be other than grand, and at certain seasons dangerous. The magnificent aspects of nature, among which the Simplon road is compelled to pass, coupled with its extent, form its principal peculiarities. These is, perhaps, no one insulated point on the whole route, which, taken by itself, merely as a gallery, bridge, or road, is not surpassed, even in its own way, by some similar object, in some other part of Switzerland. Thus, no *bridge* is equal in boldness, thread-like lightness, and giddy altitude, to that of the Reuss, near Ursern †, nor do I know that there is any greater *cutting* ‡ than at that point; but there is *so much* of this labour, and skill, and hardihood, compressed into a single route, in descending the Simplon, that while one is passing rapidly through such a scene, the mind, without stopping to analyze the parts, is apt to carry away an impression of an entire undivided whole. You are kept for hours among some of the grandest objects of the sublimest scenery of Europe, if not of the world; and few pause to detect the means that conspire to produce the impressions that all feel.

"Soon after quitting the village of Simpeln, we commenced descending, by a road that made a wide sweep, and at the end of a mile or two we entered the gallery. At this point the descent became more gradual, and we trotted on, at a good pace, for some distance further. The gorge §, through which the road runs, deepened as

* "That of the St. Gothard makes a fourth, and that by Nice a fifth." The last is called the Corniche, or Cornice.

† This is the celebrated Swiss Bridge, called the Devil's Bridge, of which more hereafter.

‡ Gallery, or tunnel. This "cutting," gallery, hole, or *tunnel*, is the "Hole of Uri," mentioned already in a former note.

§ Or hollow between the mountains.

we proceeded, until the cliffs impended over it, in places, and in the form of walls that were absolutely projecting, I should think, fully a thousand feet. Here the scenery became wildly, not to say awfully, grand; and one certainly feels a strange sensation of wonder, at finding one's self travelling through such savage passes, along a road with a surface like a floor!

"I cannot pretend to give you a very accurate notion of distances, for the moments flew swiftly, and my attention was too much attracted to the scenery, to take notice of their passage. I should say, however, it was at a point less than two leagues from the village, that we passed the portion of the road with which I was most struck, considering it merely as a work of art. At this spot, it had become necessary to descend from one level of the gorge to another that lay at some distance beneath. This object the engineers had been obliged to achieve within a very short space, and over a broken and steep surface of ragged rocks. It was done by short zig-zags, so admirably calculated, both as to the inclination and the turns, as to enable old Caspar* to wheel his four grays, on a gentle trot, through the whole descent, with as much accuracy as he, or any one else, could have wheeled a squadron of dragoons. The beauty, precision, and judgment with which the road had been constructed among these difficulties, drew exclamations of delight from us all.

"On reaching the bottom of this descent, we crossed the stream (a torrent that was raging in a rocky dell, the whole of the way, at no great distance from us) by an admirably bold bridge, and passed beneath beetling cliffs that rendered the head dizzy to gaze at. The appearance of these cliffs instantly explained the nature of the chief dangers that beset the traveller, in crossing the Alps. Without adverting to the avalanches in the spring and autumn, here was a long bit of the road where, at any moment, pieces of the rock, weighing from one pound to a dozen, might fall, from a height of several hundred feet,

* Caspar, the *voiturier*, had in charge two carriages, of which one was drawn by six horses, and the other by four.

on the head of the passenger beneath: I saw a hundred fragments, that had been half-detached from their native beds by the frosts, suspended in perpendicular lines nearly a thousand feet above me; and little freshly-made piles, that had been raked together by the workmen, lined the roadside for some distance. Occasionally, a small chip was shaken down by the passage of our own carriages; and in one instance a piece fell quite near the *calèche*, though it was too small to do any injury, had it even hit it. Old Caspar looked up, and shook his head, as we went beneath these sublime crags; intimating that it was fortunate for us it was not spring, which is the season of danger. Apart from the snow falling, the alternate freezing and thawing of that period of the year, detaches considerable masses from the rocks themselves."

It is to be understood that the Alps, upon the north and east of the semicircular, or bow-like figure, which they form, slope with more gentleness from their summits to the plains upon the outside of their range than upon the inside; that is, toward Germany and France, than toward Italy; while upon the west, they slope the gentlest inward, or toward Italy, and are the most precipitous outwardly, or toward France. Thus, in ascending the Alps on their Swiss side, we ascend (though with all its difficulties) the side least difficult; while toward Italy, the same parts of the Alps present an interior comparatively precipitous. But our tourist, having passed the summit of the Simplon, on his way to Italy, was now descending the steepest side of these northern, or northwestern Alps, where he found a swift and uninterrupted descent accordingly.

"Every one," he says, "has a tolerably accurate notion of what it is to descend a long hill; but all other descents sink into insignificance compared with those of the Alps. We were constantly and steadily going down, literally, for hours; nor do I remember, on the whole route, after quitting Simpeln, a single foot of ascent. Perfectly level ground, even, was very unfrequent; if, indeed, strictly speaking, it occurred anywhere." That is, there were none of those natural terraces, or at least occasional levels and hollows, which are so often seen to diversify the faces of mountains; and which, upon the northern side of the Alps, though too small and too elevated for the constant residence of men, form those alpine or mountain-pastures of summer resort, which, according to our tourist, usurp, among the Swiss, the very name of *alps;* while in Norway they have that of *sæters.*

"As a matter of course," continues the writer, "the glens grew deeper and deeper; and there were parts of the road which resembled yawning and frightful entrances into the very 'bowels of the land.' We passed a tall, quaint, deserted building of stone, seven stories in height; and an hospice, whose roof has been beaten in, most probably by snow. These were nearly all the signs of the abodes of men that relieved the savage wildness of the desert for miles; as, unlike the *northern* face of the mountain, there was neither pasturage nor anything else to induce human beings to dwell amid these sterile crags."

But now Italy itself was entered; and soon the proper Italian landscape and climate, upon this sunny side of the Alps, began to be manifest; and the penury, the humble buildings, and the scanty resources of the alpine declivities, on their northern aspect, to be exchanged for Italian fertility, costly edifices, and a gay and abundant population. It is easy to understand the cause of this vast change as to the two regions; for we can observe the same things in miniature every day, in comparing the northern and southern sides of a garden-wall, and the beds at their respective feet, with all the attendant differences of flowers, and fruits, and herbs, and of the humming and busy nations of insects which either inhabit or frequent them.

"We drew near," proceeds the narrative, "a small chapel in a rock, where Caspar flourished his whip, calling out the talismanic word 'Italie!' I pulled off my cap in reverence; nor do I believe one of the party passed this frontier without a throbbing of the pulses a little quicker than common. All this was produced purely by the imagination; for there was nothing yet visible to denote a change of country, beyond the little chapel already named. At length we reached a hamlet of a few houses, called Isella, where there is a custom-house and a post station.

"We had a continuation of the same scenery for some time after quitting Isella, when suddenly we burst upon a little verdant opening, that gave us a foretaste of the peculiarities of Italy. The valley widened, and on one side the mountain became less abrupt, in a way to admit of cultivation, and of the abodes of men. The habitable district was very limited, being no more than a sharp acclivity of some two or three thousand acres; but it was literally teeming with the objects of a rural civilization. The whole *côte** was a leafy cloud of lively foliage, above which peeped the roofs of cottages, wherever a cottage could stand. Tall, gaunt-looking church-towers rose out of this grateful forest in such numbers as to bespeak at once the affluence of the Romish worship, and the density of the population. The glimpse was soon over, but it left a lively impression of the principal objects, as well as of the crowded character, of ordinary Italian life.

"The mountains approached each other again, and we went rolling down a gentle descent for miles, through gorges less wild than those above, but gorges that were always imposing and savage. Here the torrent was spanned by some beautiful bridges, that were intended to receive the foot-passenger, or at the most a pack-horse. They were of hewn stone, with pointed arches, and of extreme lightness and boldness. One or two were in ruins,—a fact that bespoke their antiquity, and contributed to their interest.

"At length the mountains terminated, and an open space appeared to denote the end. A transverse valley spread across the jaws of the gorge, and a massive bridge was thrown across the torrent at right angles to our course. Old Casper cracked his whip, and soon whirled us into an entirely new region. The country was still alpine, the valley into which we now entered being completely embedded in high mountains; but the severity of

* *Côte*, side (French). In this case, the side of a hill or mountain.

the scenery had disappeared, and was now succeeded by softer hues, and a gentler nature, even the naked rocks appearing less stern and repulsive than those we had left on the banks of the Rhone. The vegetation was naturally more exuberant, and it had been less nipped by frosts; the fruits were much more generous, and all the appearances of civilization were more abundant, and, if I may so express it, more genial.

"It was Sunday, and the road was lined with peasants in their holiday attire. Fair complexions and blue eyes were the common peculiarities. We saw little obvious misery; but, on the other hand, every appearance of gaiety and contentment. As we drove into the town of Domo d' Ossola, the crowds in the streets were like bees before a hive; and Caspar was compelled literally to walk his horses, to prevent an accident *."

Thus, in a lively and intelligent description, from the pen of a transatlantic visiter, we have furnished a view of the distinguished alpine route of the Simplon, leading out of France, through Switzerland, into Lombardy, and to the city of Milan; a route so important in its history, with reference to military movements and political revolutions, and again to the happier, because peaceful, progress of commercial traffic, and of the liberal intercourse of travel. The Alps, in Italy, in this direction, are at length finally lost upon the banks of Lake Maggiore.

We have been so generally led to connect with the idea of the roads over the Alps, only impressions of terror, of difficulty, and of misfortune, relating to the severities of the northern aspects, and of the least favourable seasons, that we have thus far thought it useful to offer some correction of these exclusively darker views. We pass on, now, to notice another of the celebrated alpine tracks.

The road or pass of the Great Saint-Bernard is one of those by which travellers enter Italy over what were anciently called the Pennine Alps; and is the next, perhaps, in modern celebrity, to the passage of the Simplon. It ascends from the valley of the Rhone, and descends into

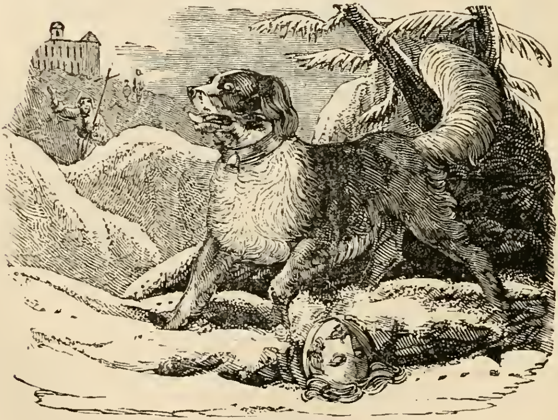
* COOPER'S *Excursions in Switzerland.*

the valley of Aosta, through which is the road to Turin, the capital of Piedmont, and thence to Rome and Naples.

From the earliest periods of communication between the inhabitants of the respective sides of these mountains, this passage has been constantly frequented, and as constantly dreaded for its dangers. Here, at the height of eight thousand two hundred English feet above the level of the sea, stand the celebrated *hospice* and convent of Saint-Bernard, the express purpose of which is that of affording all practical safety and relief to travellers in the winter season. All the funds of this establishment are, therefore, devoted to its one great work of charity.

Strangers, (it has been remarked,) upon their arrival at the convent, are generally surprised at the youthful appearance of the monks they find there; for not a single member of the community, in number from twelve to fourteen, appears to have attained the age of forty. They are monks of the order of Saint-Augustine; but they enter upon their duties at the convent of Saint-Bernard when only eighteen years of age, after vowing a period of fifteen years' duration to this life of active benevolence, in a spot where but few of them turn out robust enough to endure the severity of the cold without a fatal influence upon their health and length of life. In the year 1816 the ice of the lake which is upon the summit of the Great Saint-Bernard, and close to the convent, never melted at all; and not a week passed without a fall of snow. The greatest heat known in any summer is sixty-eight degrees of Fahrenheit; and thoughout the summer there is always ice at an early hour in the morning. The greatest cold recorded is that of twenty-nine degrees of Fahrenheit below zero; but eighteen or twenty degrees is frequent.

In every case where it is possible to render the assistance at which they aim, the monks of the Great Saint-Bernard go abroad, instead of staying at home, when the storms rage, usually accompanied by dogs of which the sagacity is such that they often discover a suffering traveller under his covering of drifted or fallen snow; and even the dogs themselves, as if conscious of their powers, and intent upon their noble duty, roam alone, by day and night, about these desolate regions; and if they find a man or woman not to be roused, and apparently near death, or if they find a child which they cannot carry away with them to the convent, they will lie down upon the body, applying their warm bellies to the heart of the sufferer, and bark or howl for better assistance. At the convent, in the mean time, in snow-storms, or in other seasons of peculiar danger, a bell is kept continually ringing, for the chance that it may direct to the convent some one who is in distress on the road, and who may either have lost his way, or be yielding to despair through ignorance that he is so near a human habitation.



Dog of Saint-Bernard.

Sometimes the monks of the convent, the servants, or the dogs, are themselves the victims, in their efforts to save those in danger or affliction. On the 17th of December, 1825, three servants of the convent, with three travellers and two dogs, had descended to the *vacheries*, or cow-pastures, at St. Remy, a league down the Italian or Piedmontese side of the mountain; which place they reached in safety, and were returning with a fresh traveller under their care, when an avalanche overwhelmed the party, and all perished except one of the dogs, which escaped through its prodigious strength, after being thrown over and over several times by the force of the falling snow. None of the bodies of the dead were found till the melting of the snow of the avalanche, at the ensuing midsummer. It has been lately reported, but, as we hope, upon no solid foundation, that, through a succession of accidents like the foregoing, the whole stock of these interesting dogs has perished, and the breed (which has been called that of the Alpine spaniel of the Great Saint-Bernard) become extinct.

English readers are so apt to hear of the road and convent of the Mountain of the Great Saint-Bernard, only as these are visited by tourists in the summer season, that they may suppose all other travellers upon the same route to be drawn thither only by the love of amusement; and may, therefore, ask why, since so many hardships and dangers are to be encountered, the monks live at the convent, or the travellers take this road, and especially when it is cold and snowy?

But the route of the convent of Saint-Bernard is, in reality, a great high-road, or common line of travel, leading to and from Valais upon the one side, and Piedmont upon the other; and is passed over like other roads, through business and necessity, still more than for pleasure. To cross this part of the Alps, even in the winter season, is by no means certainly fatal, or even disastrous. Of those that undertake the journey, by much the greater number meet with no serious difficulty; and though accidents are but too frequent, and sometimes but too serious, yet still they are but accidents; and neither numerous enough, nor, generally, serious enough, to deter such as have strong motives for the journey, from undertaking its performance. Some are led to it by the urgency of their affairs; but the greater part are either smugglers or pedlars, driven by the pursuit of subsistence and of profit, either lawful or unlawful. These persons make the traverse of the mountain, in defiance of storms and avalanches, always promising themselves to fulfil their task with safety, though sometimes lost, or thrown into difficulty at moments when they least expect it. In regions of extreme cold, like those of the heights of the Alps, the snow falls in minute particles, frozen hard, and formed into microscopic crystals, and not united into large and soft flakes, resembling feathers, as usually happens in countries like England. The fallen snow is thus a bed of dust or powder, instead of a substance consolidating under the feet of such as tread upon it; and into this bed of dust or powder, where it lies unexpectedly deep, the traveller sometimes sinks up to his middle. With nothing firm, too, upon any side, or even beneath, of which to avail himself, it may then happen that, but for the assistance of others, his extrication is impossible, and that all his struggles do but increase his danger, or even hasten his destruction.

At other times, it is to the winds, in addition to the snow, that he owes his misfortune. The snow, owing to the wind, falls or rises about him in clouds or showers of dust. His sight is obscured, he misses his path, and falls, the next moment, over a precipice.

Add to this, the dangers from the *avalanches*, or masses of snow, which frequently slide down the sides of the mountains, and are sometimes so vast in their bulk, as to sweep before them things much better able to resist them than even a whole company of travellers. In the spring, avalanches are occasioned by the melting of the snow beneath the surface, so that the masses above it lose their support. In the winter, accumulations of snow upon the steep sides of the mountains, become too heavy for the supporting power; and as, from the intensity of the cold, in the manner I have before described, the particles have little adhesion to each other, enormous masses slide off into the valleys beneath, with a noise, suddenness, and violence, which have been compared to the discharges of cannon. The approach to the *hospice*, or convent of Saint-Bernard, particularly upon the northern side, or that of the ascent from the Valais, is a labour of considerable risk, at the seasons I have mentioned. Among the latest of the sufferers were a poor travelling woman and her child.

This pass of the Alps, is one of those most anciently used; and its dangers, as we may reasonably believe, have, at all times, occasioned it to be the scene of the same local marks of charity and piety. The mountain had once the name of Jupiter, or Jove, or Joux. Remains of a temple of Jupiter are still extant upon it, close to the convent; and the modern building of the convent of Saint-Bernard, stands upon the site of an older one, which was called the convent of Mont Joux. There is historical mention of a convent here, as early as the year 832; and it bore, even then, according to some, the name of Bernard, derived from one or the other of two Bernards, of the royal family of France.

But the actual *hospice* was founded in the year 962, by a Bernard, of a noble family in Savoy, who also founded, about the same time, a similar establishment upon the more westerly pass, called that of the Little Saint-Bernard. It has been conjectured that he was particularly induced to form establishments at these places, by the coincidence of his own name with the names they bore. But, this, perhaps, may be doubted, when it is known that the name given to them by himself, instead of continuing that of "Saint-Bernard," was "Saint-Nicholas de Myre." He died in 1008, after having presided over his convent of the Great Saint-Bernard, forty years; and being subsequently canonized himself, he became the second "Saint-Bernard" of the place.

In the time of the pious founder, and for many subsequent years, the safety of the pass was, at least, as important as now, and its dangers almost infinitely greater. Besides its value as to affairs of traffic, it was the route to Rome for the pilgrims from all the north of Europe; and besides dangers far greater than at present, derived from all its difficulties of nature, it was harassed by robbers, and by all the evils of barbarian warfare. Before the eleventh century was closed, the Saracens, penetrating into this part of Europe, carried fire and sword into the valleys of the Alps; and, burning the edifice raised by Saint-Bernard, left its ruins to be a den of marauders, who set a barrier across the passage, and who, if they did not plunder the travellers, at least obliged them to pay heavy tolls. The Normans, attempting to put an end to at least a part of these afflictions, attacked and killed the banditti stationed to enforce the tolls, and broke down the barrier. The relief, however, was either incomplete or only temporary. Outrages were still practised; and Canute, king of England and Denmark, was among the princes of Northern Europe, who made an appeal to the Pope, upon the horrors and grievances endured by their subjects in their pilgrimages to Rome; and who, from the danger of enemies and robbers, could venture to cross the Alps only in companies of four or five hundred persons at a time.

The complaints, thus made, were not unattended with success. The court of Rome, after a time, found means to put down the robbers, to abolish the tolls, to make the country peaceable, and to encourage the monks of Saint-Bernard to rebuild their convent; and Canute was able to write to the bishops in his two kingdoms, informing them that he had ensured the safety of pilgrims through all the route of the Pennine Alps.

The roads, or passes of the Alps, as well as the Alps themselves, are frequently peopled with Romish pilgrims to this very day. England may now send few, perhaps none; but the shrines of Rome and of Loretto are still frequented by way of the Alps, especially from the Romish parts of Germany; while, for those without the means of long and expensive travel, there are shrines within the bosoms of the Alps themselves. One of these is that of Einsiedeln; and, by citing two or three traits of the travel of its pilgrims, to assist in the solemnities observed at it once in every three years, we shall obtain some partial notion of the scenes of pilgrimage upon the Alpine passes, in the time of Canute, and through other ages.

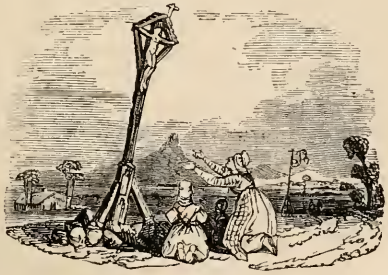
"Near Rotenthurm," observes the tourist, to whom we were lately indebted, "we overtook a party of pilgrims proceeding towards the shrine of Einsiedeln, where, it was supposed, many thousands would soon be collected, to assist at a solemn triennial ceremony. There were thirty-two in this company; two-thirds females; and they had come from Alsace, or more than a hundred miles, to be present on this great occasion. A few were barefooted;

and all prayed aloud, without ceasing, one repeating after the other. Deeper voices were heard in the rear; and another party, of sixteen, mostly men, ascending a knoll in the road, advanced toward the shrine in the same manner. The effect of these little processions, and the beautiful blending of prayers, was singularly touching.

"Einsiedeln, unlike Loretto, has never been much frequented by the great. Italy has attractions in these matters, which Switzerland can scarcely hope to rival; but, at the present day, Einsiedeln has, probably, more votaries than Loretto; though they are poorer persons.

"Pilgrims were arriving throughout the day, in parties varying from a-dozen to a-hundred. Their approach was always announced by the untiring repetitions of the prayers, which, in the distance, especially when male and female voices alternated, was poetical and plaintive. Most of the pilgrims were Germans. A large portion were from the Black Forest, though there were also a good many Alsacians, and a few Italians, in the different groups."

Thus pilgrimage is now, as it was more than a thousand years ago, one of the great features of travel in the regions of the Alps.



We proceed now to point attention to some of the other principal roads over the Alps.

The Romans, who, before the reign of Augustus Cæsar, were but little acquainted with the Alps, or with any part of the region which these mountains enclose, reckoned, in the time of the republic, four principal roads or passes. The moderns, as was mentioned, take notice of at least twelve roads, pursued between the Gulf of Genoa upon the west, and the head of the Adriatic upon the east. Of the roads of Mount Simplon, and the Great Saint-Bernard, we have afforded some description; and, to complete the list of twelve, there should be added, those of the Little Saint-Bernard, Mount Saint-Gothard, the Grimsel and Gries, the Bernardin and Splügen, Mount Brenner, Mount Stelvio, Mount Cenis, Mount Genèvre, the Col-de-Tende and the Argentière, and the Cornice; the last carried along the feet of the Maritime Alps, and, therefore, coasting the Mediterranean.

The pass of the Little Saint-Bernard crosses the Alps to the southward and westward of the Great Saint-Bernard, and between both rise the magnificent and celebrated Mont Blanc, and Monte Rosa.

The Little Saint-Bernard is in comparative neglect, both as to the number of travellers frequenting it, and as to the labour bestowed upon its improvement. A high interest, nevertheless, attaches itself to this particular route between France and Italy, or between what were once the Transalpine and Cisalpine Gauls; both for its picturesque beauty, and for the historical recollections which belong to it, if, with the best modern authorities, we believe it to have been the scene of Hannibal's celebrated passage over the Alps.

The road of the Saint-Gothard is one of the most frequented passes of the Alps. A new road, as well as a new bridge, less romantic than "the Devil's Bridge," but so substantial as to be secure for carriages, have lately been completed upon it. The tourist gives the subjoined accounts of both, while in their progress: "Travellers, it is true," he observes, "do not cross the Saint-Gothard so often as they cross by the Simplon and Splügen, for as a carriage-road it is imperfect*. Fifteen thousand persons, it is *calculated*†, however, go into Italy, or return by that

* The "Devil's Bridge" having been adapted only for foot-passengers, and for pack-horses, or pack-*mules*.

† "Calculated" is the word constantly substituted in the United States, for reckoned, or supposed.

route annually. The distance from Fluelen, on the Lake of Luzerne in Switzerland, to Bellinzone near Lake Maggiore, in Italy, is seventy miles; nearly the whole distance being either a continual ascent, or a continual descent. Three hundred pack-horses or mules, cross the mountain weekly, for a portion of the year.

The Devil's Bridge.

"The cantons of Uri and Tessino, in which the whole of this pass lies, have partly (this was in the year 1828,) completed an excellent carriage-road, with the hope of attracting some of those who are distributing their money so freely in the country, and of making their commercial communications more perfect. The plan comprises not only a new road, but a new bridge in this gorge; and men, slung in ropes, were then at work blasting rocks above the present road and bridge, with this object. The new bridge is to be both longer and safer than the present." The "present," or old bridge, it may here be added, consists, as the figure will show, of a single arch. Of this arch, the span is eighty feet; and the bridge stands at about seventy-five feet above the bottom of that fall of the Reuss over which it is carried.

Without noticing every track, let us now proceed to the Brenner.

The road which leads from Germany into Italy by the pass of Mount Brenner, is the lowest, even at its greatest elevation, of any of those which cross over the great chain of the Alps; for it is nowhere more than four thousand seven hundred feet above the level of the sea. Before the formation of the route of the Tende, this was the only pass by means of which travellers could gain the opposite side of the mountains without quitting their carriages. The route lies directly through the Tyrol, from Innsprück upon the German side, to Verona upon the Italian; that is, to the plains of Lombardy.

The importance of a free communication between the German possessions of the House of Austria and its Italian states, led, it is probable, to the construction of a good road by the Brenner at an earlier period of this portion of the Austrian sovereignty.

Insprück, the chief city of the Tyrol, is situated in the valley of the Inn, nearly midway between the source of that river, and its confluence with the Danube. At this spot, the waters of the Inn are more considerable than those of the Danube.

From the summit of the passage, the road speedily carries us by an easy descent, to Sterzing, where, emerging from the high banks of the Eisach, we find the country opening widely to our view; and already the products of the soil mark the southern side of the Alps. Soon, however, after leaving Sterzing, the road enters a narrow valley, deep, and darkened by mountain-pines; and scenery of this character continues almost uniformly to Mittenwald.

But we are here upon ground for ever to be celebrated in respect of an incident in modern military history, which we shall relate in the words of a tourist to whom we are chiefly indebted for the preceding topographical particulars of the Brenner.

" Every step," says he, " of this passage was disputed by the Tyrolese, in their fearful and unequal contest with the French and Bavarians in the year 1809; but a spot, about two miles below the post-house of Mittenwald, is pointed out to the traveller as the scene of a *ruse de guerre* of the famous Andrew Hofer, when he attacked the Bavarians from an ambuscade.

" The spot is not such as a stranger would at first suppose was well-chosen for the fearful purpose for which it was selected. The mind would picture to itself a situation overhung with precipices; but here the narrow valley suddenly spreads out on the left of the river into a little plain, about a quarter of a mile broad and half a mile long, around which the mountain-base sweeps like an amphitheatre. A little church, and a village through which the road passes, occupy the left bank of the Eisach. On the right, the mountain rises abruptly from the bed of the river.

" This was the spot chosen by Hofer for the ambuscade of the Tyrolese. He had caused to be prepared rocks, trunks of trees, and other heavy bodies, on the rise of the mountains above the plain, which were so placed, that when the props were withdrawn which supported them, these masses rolled down the declivity, and across the plain, overwhelming and destroying everything in their way.

" The French and Bavarians, who had entered the Tyrol to suppress the insurrection, proceeded in pursuit of a small party, who retreated step by step, fighting as they fell back, into the passes of the Brenner, and the forests of Mittenwald. Circumstances had excited in the invading army some fears of an ambuscade; these had been reported to the Duke of Dantzic, who commanded the troops, but he ordered the pursuit to continue, though he prudently retreated to a place of security. About four thousand Bavarians, who had been ordered to advance, having entered the fatal spot, a cry was suddenly heard in the mountain,—'Hans! in the name of the Holy Trinity, cut all loose!' In less than a minute thousands were crushed by the falling masses; the remainder, in their terror, attempted to retreat; but the unerring balls of the Tyrolese increased the numbers of the slain.

"Observing the effect of their *ruse* upon the terrified enemy, the Tyrolese descended from their fastnesses,—even young boys and girls joined in the attack,—and, rushing upon their invaders, further thousands of the Bavarians and French were killed. They retreated about fifteen miles before they could be rallied; but, so great was their terror, that when Hofer again appeared, they fled before the Tyrolese, who fell with redoubled fury upon their invaders, and completed the victory."

The modern road of the Cornice, the last of the roads before-mentioned, is part of the Aurelian road of the ancient Romans. It runs along the feet of the Maritime Alps, and along the shores of the Mediterranean Sea, between Genoa and Nice.

The Aurelian road was the principal as well as the most ancient of the roads which led from Rome into Gaul in this direction. It was constructed by the Consul Aurelius, about the year of Rome 605, and from him called Via Aurelia; and at the period of its greatest extent, was described as forming the route from Rome to Arelate, the modern city of Arles, in Gaul or France.

"Strictly speaking," says a recent tourist and topographer, "the Cornice is not a pass of the Alps, but rather a road by which the Alps are avoided. It was one of the earliest passes known between France and Italy; and, from its recent completion as a carriage-road, is likely to become one of frequent use, particularly for invalids. Hitherto, from the necessity which existed for travellers performing part of the journey on mules or on foot, ladies, and persons in delicate health, have been generally withheld from the enjoyment of this delightful route in their passage into Italy, and have been compelled to pass over the High Alps, by the routes of the Simplon or the Cenis, where all that the art of man could accomplish has been effected to render the passes fit for communication by carriages; but where barriers of clouds, and snow, and storms, often oppose the progress of the traveller. By the route of the Cornice, the invalid, who leaves England even in the depth of winter, may reach the warm and genial climate of Italy without encountering the Alps in his passage. From Nice to Genoa the traveller seldom loses sight of the Mediterranean, and then only for short intervals. The road is carried along the shores, or round the bold and beautiful capes whose precipitous fronts sink abruptly into the sea. From these capes, the bays, which indent the coast, are successively presented to the view of the traveller, as he winds in his carriage around the promontories, over a road of admirable construction, where, a few years since, a mule's back would have been a dangerous station on the narrow paths and giddy heights which overhang the sea*.

The modern improvements of the Cornice† were begun by Napoleon Buonaparte, during his sway in Italy; but it was not till the summers of the years 1826 and 1827, that by the care of the Sardinian government it was made passable for carriages throughout. There is some embarrassment in reconciling the recent difficulties of the Cornice, with the ancient character of the Aurelian road; but it is a pass of extreme interest, at once for the facilities which, at this day, it offers to all the west of Europe for travelling into Southern Italy; for its true, and even

* Brockedon's *Passes of the Alps*.

† The Corniche of the French, and Cornice of the Italians, is so called in the same sense as that of the English architectural term *cornice*, and implies a road which is carried along a ledge upon the side of a precipice, so as to have heights above it, as well as depths below it; like the Norwegian road, (page 192.) A road like this is described by the French as *en corniche*; or overhanging, in the manner of a *cornice*.

for its fabulous history; for the Augustan triumphs of which it has been the scene, and of which it bears the memorial; and for its beautiful and healthful features of prospect, both by sea and shore, charming to the eye, and cheering to the spirits.

We cannot better close our account of Alpine roads, than by laying before the reader the following narration, with the substance of which a modern traveller has supplied us.

Gaspar Stoeri and two of his friends were one day chasing chamois on Mount Limmereu. While they were traversing the snows with that confidence which the idea of perfect safety inspires, Stoeri sank into a deep abyss of dissolving ice. His friends were horror-struck; they conceived that instant death awaited him, or that he would survive only to contemplate its slow but inevitable approach; pierced as he was by cold; bruised, bleeding, motionless. Despairing of success, they yet reflected on the means by which they might effect his deliverance; they could not leave him to perish; their struggles to save him would, for a few minutes, assuage their agony. They fled to the nearest cottage, which was three miles distant, to procure ropes; none were to be found; a wretched counterpane was the only thing that could prove useful to them; they cut it into strips, and hurried from the cottage.

Poor Gaspar was almost perishing when they returned to the brink of the chasm; he lay wedged in the bottom of this rugged, deep, and narrow cleft; nearly one half of his body was plunged in ice-water, and such was the depth of it, that he could not see its bed; with his arms extended on the broken and melted ice, he awaited approaching death. We might picture his situation; but the horrors of his mind must be for ever confined to his own breast.

He was yielding to the excess of his sufferings, and was commending his soul to the Deity, when the voices of his companions fell upon his ears; and as they spoke, they lowered the bandages which they had fastened together. Although dying a few minutes before, the prospect of speedy deliverance, gave him energy and courage, and he was enabled to fasten the bandage around his body. His friends drew him gently from the chasm, he was approaching the verge of the precipice, he had almost embraced his deliverers, when the bandage broke, and he again sank.

If deliverance was almost hopeless before, what was now poor Stoeri's situation! One-half of the bandage had fallen with him, his blood was freezing, the second shock had almost rendered him insensible, and, to consummate the terrors of his situation, and for the extinction of the last faint spark of hope, one of his arms was broken by the fall. What less than a miracle could save him! With sinking hearts, his friends renewed their endeavours to preserve him; the bandage in their hands was again cut, and lowered into the chasm. The pain and distress with which poor Gaspar made one last and desperate exertion to save himself, may be conceived when it is stated, that with one arm he supported himself from sinking, and with the other, broken as it was, he twisted the bandage round his body, and fastened it. He was then drawn to the summit of the precipice a second time, and life seemed ebbing fast from him as he fainted in the arms of his companions. He was conveyed to a cottage, where he slowly recovered from the effects of his sufferings.

If we now visit France, "the land of beautiful sites and bad roads," as one of its most talented writers calls it, we shall find the roads, bridges, harbours, and light-houses to be all under one especial board of engineers. Youths are educated at the Polytechnic school in every branch of civil engineering, and are then employed by the board. This centralization is productive of many valuable results.

The general declivity of the new road over Mount Cenis, one of the Alps, is one inch in fifteen or twenty; and it is never greater in the steepest part, that is, in the fourth and fifth turns that wind up over Lanslebourg, than one in twelve. The road over the Simplon was likewise executed jointly by the French and Italians, under the government of Napoleon, from 1801 to 1805. The greatest declivity is one inch in twenty-nine; so that an English stage coachman might trot his horse up almost the whole way. The longest gallery or tunnel is about 500 feet under ground.

"The roads in France are generally rough in their original formation, and still rougher from want of care in repairing them, as the traveller feels to his cost in passing over the primitive mountains in the south of that country, where the roads are certainly very different from those which are made by Mac Adam across a bog; although some of the more recent French and Flemish pavements, as long as they remain unimpaired, are truly excellent. The new pavement between Cologne and Brussels, for example, is far more perfect than some of the unpaved parts of the continuation of the same line of road to Calais, although the civil postmasters are in the habit of congratulating their English guests on the 'fine gravel road' they will have to pass over. In Germany they have few pavements, and the roads, except in sandy countries, are generally kept, or keep themselves, in good repair; that is in the south and west of Germany. Mr. Cripps informs us that the great roads in Sweden are beautiful; they are very slightly convex, and are made of granite broken to the size of a walnut."

There is, perhaps, no more striking instance of the bad effect of want of unity of purpose, than is shown in the road from Hamburgh to Lubeck. This distance (less than thirty miles), is the property of three different states, and a consequence is that the road is execrably bad, although it serves to connect two populous and important towns. Mr. Barrow says, "Nothing can be imagined more execrable than the state in which we found the road. It lies over a loose sandy soil, through which we were dragged at the rate of about three miles an hour; which we certainly did not exceed at any one period of the journey, although our carriage was of a very light construction, and the luggage trifling. Large rough stones lay about in every direction; they might once have helped to form the road in the shape of a pavement, but were now loose in the sand. The tardiness of the journey was occasioned partly, but not wholly, by these stones; for independent of the momentary necessity of turning aside to avoid them, the carriage was every now and then either jolting against them with considerable force, when, from the jerk, away went the harness as a matter of course; or else it was up to the axle-tree in deep-sand . . . . . In short, though a public road between two large cities, it is perhaps the very worst in civilized Europe."

Yet we are told that when England was in a very unfavourable condition, as related to *roads*, France, and the other principal countries of Europe were comparatively so well off in this respect, that the English sought foreign lands, mainly for the greater facility of travelling. If the English were behind the French and other continental nations in the art and practice of road-making, one or two hundred years ago, they are now decidedly superior; and not alone in road-making, but in most of the other arts and professions, which conduce to the comfort and convenience of life.

Tartar Palanquin, with Warriors.

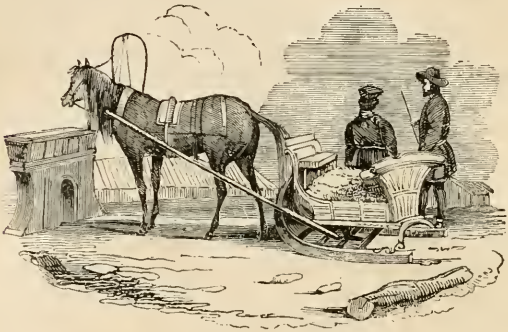
CHAPTER XIV.

Primitive Modes of Travelling.—Pack-horses, Sledges, Sedans, Palanquins, Litters.—Introduction and Improvement of the Wheel—Two and Four-wheeled Carriages.—Springs.—Ancient Chariots.—Fore and Hind-wheels.—Old Coaches, &c.—Vehicles of Africa, of Russia, of Sweden and Norway, and of Italy.—Irish Jaunting Car.—Vehicles of England.—The Dray, the Gig, Tilbury, &c.—State Carriage of England.—The Mail and the Post Office.—Stage Coaches, Hackney Coach, and Cab.—The Omnibus.—French Diligence.—Construction of Wheel-carriages.

We will not spend time in discussing the question—"Which is the most important to a land-traveller, the vehicle in which he rides, or the road on which the vehicle moves?" We shall not be much in error in referring to the case of the bellows-blower and the organ-player, and in deciding in the present case, as in that, that the one cannot do without the other. We have been attending to roads of various kinds, and we must not now neglect to introduce our readers to some of the various species of carriages which assist the land-traveller.

The most obvious means of locomotion for a land-traveller are the two legs which nature has given him; and if he want to carry a burden, his shoulders, his back, his head, or his arms, become the depository thereof. From this point, then, we set out: the legs were the first travelling carriage, and the shoulders, &c., the first baggage wagon. But this could not long continue; man is prone to avail himself of the assistance of other things when opportunity offers, and he could not be long in perceiving that the form of four-footed animals enables them to carry a burden with more ease than man; consequently, from early times, animals of various kinds have been used as "beasts of burden," such as the horse, ass, mule, ox, camel, dromedary, &c. The muleteer of Spain still continues to dispense with a wheel-carriage; indeed a carriage could not possibly pass over the mountains which the muleteer traverses. In many other countries, animals, instead of drawing vehicles, containing baggage, &c., carry that baggage on their backs, or in hampers, slung on each side of them. This is especially the case in Iceland; Mr. Barrow states that there is not such a thing as a wheel-carriage in the island, nor scarcely a road on which a carriage could pass. Two oblong boxes are formed, and slung across the back of a horse, and into these boxes are put provisions, merchandise, clothes, and everything else necessary to be transported from one part of the island to another. There is, perhaps, no other part of the world equal to Iceland in civilization, which is without wheel-carriages, except in purely mountain districts.

But, from a very early period, it must have been held desirable to free the animal—the horse, or whatever else it might be—from the task of *bearing* the burden as well as drawing it. The first approach to a carriage was made with this view. This we observe to be the case with the vehicle used by the Poles, which seems to be only an improved condition of the sledge, a vehicle ordinarily used in the earliest stages of society; but perhaps nothing can be more absolutely primitive as a carriage for bearing the weight of traveller and baggage, instead of throwing it on the animal, than the *sledge*. This vehicle is seen in the streets of London, where a brewer, if he have to send a small cask of malt liquor some short distance, does not think it necessary to employ a wheel-carriage, but places the cask on a little sledge, which slides merrily over the rough stones. But the most important examples of the sledge are seen in those northern countries, where the ground

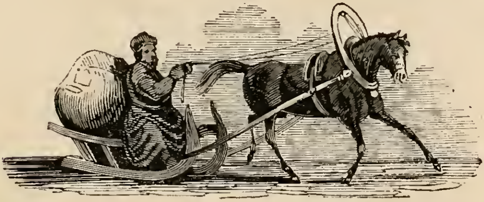


Polish Cariole.

is covered with ice and snow the greater part of the year. Wheels would sink in the snow, would be dangerous over ice, and would possess other disadvantages likewise; but

Lapland Sledge and Reindeer.

a simple sledge, with smooth surfaces for touching the ground, and with reindeer harnessed to it, runs on with amazing swiftness. The sledge is extremely slight, and covered at the bottom with the skin of a young deer, the hairy side sliding on the snow. The person in the sledge guides the reindeer with a cord fastened round the horns, and encourages it to proceed with his voice, while he drives it with a goad. When urged strongly, the reindeer will travel fifty or sixty miles at one stretch; but in such a case the poor creature works itself to death, and generally dies in a day or two afterwards. As a general rule, they can go thirty miles without stopping, and without being over-fatigued, and frequently perform 120 English miles in a day. The best state for the motion of the sledge is on a bed of snow coated with ice. In the northern parts of Russia, the sledge is frequently used by the boors with a horse, instead of a reindeer.

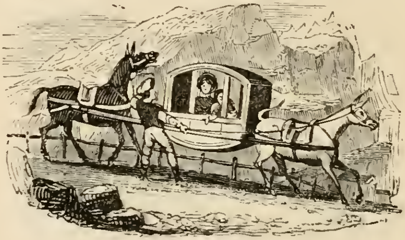


Russian Sledge.

But in those countries where the irregularities of the ground render a sledge useless, travellers must either go on foot, or on the back of some animal, or in a vehicle of some other kind; and as the back of an animal, however pleasant and convenient it may be for the young and healthy, is but ill calculated for the aged or infirm, a motive at once exists for devising a vehicle for the use of the latter. The most simple, perhaps, is a sledge, lifted from the ground, and borne by two or four bearers. This principle once established, the modifications of it might be, and have been, numerous. The English *sedan chair** of the last century was one specimen of such a vehicle; the *palanquin* of the East Indies at the present day, borne by

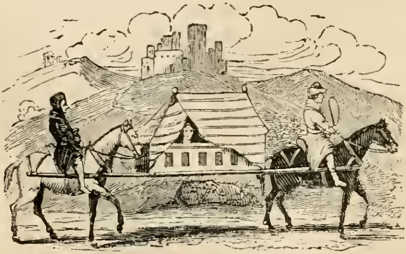
* Mr. Hudson tells us that sedan-chairs are very much used in China, the ground being "cultivated to such an extent that the *roads* were not left wider than a narrow footpath."

two, four, or eight Hindoos, is another instance; which vehicle, when used for the purposes of war, or state grandeur, is mounted on the back of one or more elephants, as shown in the engraving, p. 226, so that the next advance would be to make animals perform the parts of men, and bear the sledge, sedan, litter, or whatever else the vehicle might be, by means of two poles, one on each side of the horses. This mode of conveyance in a litter is much in vogue in the south of Europe, the litter being supported by two mules, one before and one behind, with the poles



Litter borne by Mules.

fastened to their pack-saddles. One advantage of such a vehicle is, that it is capable of passing along narrow paths, as nothing but the feet of the mules touch the ground. A litter borne by horses was used in this country at the beginning of the fourteenth century.



Early English Horse Litter.

But still the animal has likewise to *bear* the weight of the vehicle which it draws, and the gradual introduction of *wheels* was the means by which this inconvenience was ultimately overcome. If a plumber wishes to move a roll of lead, or a mason a block of stone, he finds how much his labour is lightened by placing a roller under the moving body, so as to remove it from contact with the ground; and if a mass of any substance whatever is to be moved along the ground, we find how much more easily this is accomplished when the body approaches in form to the cylinder, or still better to the sphere. Now these well-known facts were the circumstances which led to the origin of the wheel. If a sledge, litter, cart, or other vehicle, could be so placed on a roller that while the latter was rolling along the ground, the former would maintain its proper position, an important improvement would be made. But if the vehicle were actually nailed or fastened to the roller, it would necessarily rotate as often and as fast as the roller rotated. Thus sprung up the necessity of having an axle distinct from the roller, but working in a hole through the middle of it, and of attaching the vehicle, not to the roller, but to the axle. This is at once exemplified by our garden roller, in which the frame-work of the vehicle, be it slight or complex, is attached to an axle passing through the middle of the roller, and not to the roller itself.

But a continuous roller is neither necessary nor desirable; if the two ends rest on the ground they will support the vehicle, which may be attached to a pole or bar, or axle connecting those two ends. This is the first germ of the roller being superseded by the wheel; instead of a roller, two slices from it would suffice, and these two should be connected by an axle, on which the vehicle should rest. What can be a more primitive example of such a vehicle than the Highland cart represented in page 176? But primitive though it be, it possesses the general principle that belongs to all our wheel-carriages. In some parts of America, and in other places in the old continent, the wheels are literally nothing but transverse slices cut off from the trunk of a large tree. Such is the case with the common cart, still used by the people of the lower part of Italy, for removing the fruits of the ground.

Calabria was one of the divisions of ancient Italy, and forms now part of the kingdom of Naples. Carts with wheels of this nature were observed by Mr. Hudson in China.

Calabrian Cart.

Afterwards came the conviction that wheels might be made larger, and in every respect more convenient, by having them hollow instead of solid; that is, having a central nave, from which spokes radiate in every direction, the remote ends of the spokes being encircled by a rim. This was the more desirable, since it soon became evident that a large wheel moves with less friction than a small one. By degrees, this form of hollow wheel became generally approved, and the skill necessary for its construction was gradually developed. In some parts of the world, not only these wheels, but the whole vehicle, is made without the aid of a morsel of iron, or any other metal. Such are the wagons and carriages of Chili, as described by Mrs. Graham. The wheels have a double felly, or rim, placed so that the joints in the one are covered by the entire parts of the other, and these are fastened together by strong wooden pins; the rest is all of firm wooden frame-work, bound with hide, which being put on green, contracts and hardens as it dries, and makes a very secure band. The flooring of both coach and cart consists of hide. The cart is tilted with canes and straw, neatly wattled.

Wagon of Chili.

The next improvement for a vehicle is a contrivance for breaking the violence of the concussion occasioned by the motion of vehicles made of so many separate parts. One such contrivance is to have a seat for the traveller swung by cords, or straps, from the sides of the vehicle, instead of being nailed to it; such is the case in the very numerous light carts of the London tradesmen. Another and more important means of attaining the same object is to allow the whole body of the vehicle to swing, or to be suspended, by applying springs of various kinds between the vehicle and the axle. Such springs are extremely diversified. First, we begin with the heavy *wagon*, which, in consequence of the enormous weights it has to bear, must be built with every attention to strength, so that elasticity is but little attended to; this we see exemplified in the following cut of a rural wagon of Switzerland, which may be regarded as a common model of the sort in civilized life. Then we have the *spring van*, in which the body of the vehicle rests on springs which intervene between it and the axle. Of these there are many varieties. Lastly, we come to the private carriage, and vehicles of a similarly elegant and commodious class, in which the body is not only separated from the body by springs, but those springs have such curved and variable forms, that the body literally swings, and effectually breaks the effect of any sudden concussion.

Swiss Hay-Wagon.

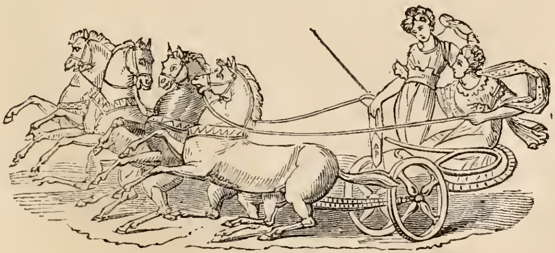
Before entering further into the forms and uses of modern carriages, it will be desirable to cast a glance at the structure and purposes of those of ancient date in the most civilized nations of the world of antiquity. In these, the Egyptian, the Grecian, and the Roman, there is a general resemblance, as far as relates to their *chariots.* The Egyptian chariot is, in all probability, such as was used in the days of Pharaoh, king of Egypt, when he pur-

Ancient Picture of an Egyptian Chariot.

sued the fugitive Israelites. The chariots of the Jews were similar to those of the Egyptians; for the former sent for their chariots from Egypt, the great mart for them. Such a chariot as is represented in the foregoing cut, was used for the purposes of war or chase. The chariot was usually made of wood, though the framework was often made partly of brass. It was mounted on two wheels, which were made sometimes of wood, and sometimes of metal.

The chariots usually carried two warriors; one of whom chiefly attended to the management of the horses, while the other wielded the weapons of war. In our figure, the charioteer is seen pierced with an arrow. The ancient chariots were open at the back, and without a seat. They were regarded as the most valuable part of an army's equipment in very ancient times; and seem to have been most chiefly in use, before that of cavalry or mounted horsemen. Their use was confined to the principal men in the army.

The accompanying figure, which is that of a Grecian chariot, shows the manner in which the Greeks frequently yoked their horses at a race; which was one division of the Olympic games.



Ancient Picture of a Grecian Chariot.

The Roman, contending at the Olympic games with five horses yoked abreast to his chariot, is given in the annexed cut.

With the later Greeks, and with the Romans, chariots were chiefly used at the races of the Olympic games in Greece.

Ancient Roman Charioteer.

Let us now revert to the condition and uses of modern vehicles, whether having two or more wheels.

So long as a vehicle is moved on two wheels, the task of turning round a corner, or in other ways altering the direction in which the vehicle is moving, is no difficult matter; but if four wheels be employed, the vehicle must be proportionably lengthened, and the difficulty of moving it becomes increased. The necessity of having four wheels obviously arises from the great weight which vehicles are often required to draw. This weight, if only two wheels were used, must be poised nearly over the axle which unites them, and the horse or other animal drawing it, would have to bear a considerable part of the burden, in addition to the labour of drawing it. By having two additional wheels, the vehicle is placed in a condition of wholly supporting itself on the wheels, and the animal has only to drag it along, and not to bear any of the burden, except the shaft or shafts to which it is fastened.

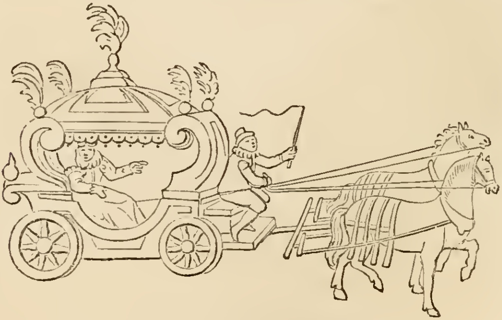
Now, in order to turn a vehicle on four wheels, if they were so united as always to maintain the same relative positions, the labour of the horses would be tremendous, arising from the large amount of friction which would necessarily result from the formation of the vehicle. To obviate this, attention was turned to the practicability of making a kind of hinge or pivot in the bar which joins the front wheels and their axle to the back. This is the plan which we see adopted: the axle of the front wheels turns upon a pivot, so that when the horse is required to take a new direction, and his head is turned accordingly, the front wheels move round to the required direction very readily, with very little friction, and the hinder wheels are allowed time to turn more gradually.

But to effect this turning of the front wheels, a particular arrangement of the parts is necessary. If the front wheels were of the same size as the hinder, and the body of the vehicle were placed within all of them, the front wheels could not turn round on their central pivot without striking against the sides of the vehicle, and their range of motion would be extremely small. On this account, therefore, the general rule has been, to make the front wheels so small that they can go *under* the body of the vehicle in the act of turning, and thus keep a clear range for their motion. This has the good effect of greatly facilitating the power of the vehicle to turn, and the bad effect of greatly increasing the amount of friction, for the smaller a wheel is, the greater number of times must it revolve to pass over a given distance, and the greater is the amount of friction at its axle. Whether this defect is or is not unavoidable, is a point on which we shall speak hereafter.

The foregoing are what we may perhaps term the *natural* steps by which man has improved his modes of conveyance from place to place. First, the backs of animals—the sledges, litters, sedans, &c., slid along the ground, or carried by men or by animals—then vehicles with the semblance of a wheel under them—then improvements in the wheel—the adaptation of springs of various kinds — two additional wheels—facilities for turning the vehicle, &c.

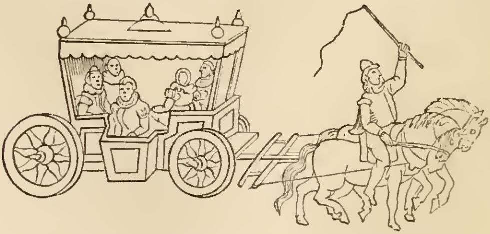
Vehicles of various descriptions have been in use from very early ages and are depicted on coins, marbles, frescoes, and other monuments which hand down to us the usages of the ancients. The war-chariot just given was a form as simple as it was well known; and the practice of inserting scythes in the axles, and driving the chariot among the enemy, was one means of increasing the havoc which marks the progress of war.

At what time, and by what nation, private carriages drawn by horses were established is by no means certain, nor is it of much importance; suffice it to say that English, French, Italians, Spaniards, and Hungarians, lay claim to the honour; so we will leave the learned in these matters to discuss and settle this point, and proceed to speak of the introduction of wheel charriages for pleasure into England, which took place in the reign of Queen Elizabeth. We are told, however, that a clumsy kind of car, upon four wheels, was used by the Saxons to carry great personages. The first vehicle, however, which was distinctly called a *coach*, was Queen Elizabeth's.



Queen Elizabeth's Coach.

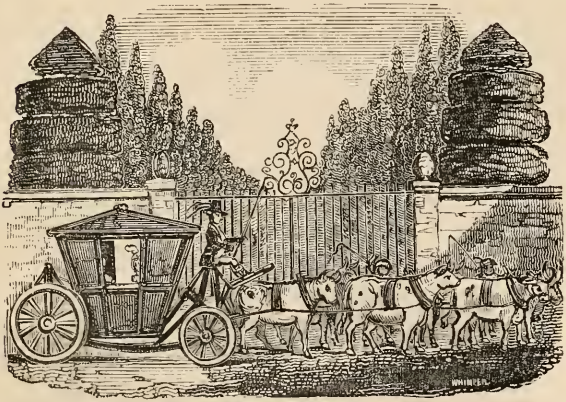
In this coach she went from Somerset-house to Paul's Cross, to return thanks for the destruction of the Spanish



Carriage of Queen Elizabeth's Attendants.

Armada. The subjoined is the carriage of her attendants, in which may be noticed two odd-looking seats, called *boots*, where two of the officers sat, as the Lord Mayor's do now, back to back.

We have heard of a lady, who lived during the civil wars of the seventeenth century. Her husband being detained a prisoner in London, she set out to effect his ransom. All the horses having been taken away by the other party, she put eight oxen to her carriage, and got from Somersetshire to London in a fortnight! If she had used horses, she might have accomplished the journey in a week, which now takes a day.



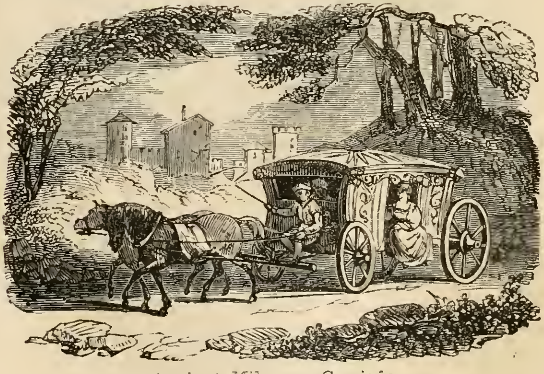
Somersetshire Lady on her Journey.

These coaches were very clumsy and uncomfortable. They had no springs; and the state of the streets and roads occasioned sad jolting. As fashion, however, brought them into use, the nobility vied with each other in the number of their horses, which were often increased from two to eight. But, in the early days of *coaching*, it was deemed to be disgraceful to any of the male sex to ride in a coach. Coaches and chariots were not introduced into Scotland till the early part of the last century. Before that time, we are told, the nobility used to travel in a vehicle similar to a Noah's Ark.

English Phaeton of the Eighteenth Century.

The annexed cut represents the English Phaeton of the early part of the last century.

The form and convenience of vehicles are dependent as much on the nature of the country which they are to traverse, as on the intelligence of the nation who use them; and those two circumstances combined, give a great diversity to the modes of travelling by different nations. The annexed represents an ancient covered carriage, much in use at Milan, in the North of Italy.



Ancient Milanese Carriage.

The vehicles used in South Africa by the settlers, planters, &c., are nearly always wagons drawn by oxen;

clumsy in shape, and capacious, they often serve as a complete kitchen, in which the culinary operations of the traveller are carried on, and in which he likewise frequently passes the night.

In Northern Africa, vehicles are very various, according to the rank or intelligence of the people; but, in general, vehicles are not much employed, the camel in the deserts, and the horse in other parts, being a much more prevalent mode of conveyance. When Captain Lyon was in Africa, the Bey of Fezzan consulted him about making a coach, and the Captain offered that if the Bey would procure wood, his man, who was a handy fellow, should make the coach. A rough sort of box was made, six feet long, three feet wide, and four in height. This was covered like a higler's cart, with an arched top, having a door behind, by which a person could enter; "but Mukin," says the Captain, "finding that he could squeeze himself into a smaller compass, had it reduced in such a way as to render it necessary for him to be pushed in and shot out like a sack of coals." The body was made, and mounted on two poles, as shafts, springs being an unattainable luxury, and the poles were fixed to two wheels taken from a piece of artillery. The Bey and numbers of his people came to witness the progress of the work, and asked whether the king of England and his wives rode in such a carriage. "I was frequently puzzled what to answer," continues the writer; "for, to say the truth, though Belford, considering his want of materials, had done wonders, it very much resembled one of those market-carts which are dragged about London by donkeys. It soon, however, lost that appearance, being covered with a splendid hood of scarlet cloth, and having a bed laid inside it." The Bey had it painted with verdigris mixed with vinegar, and made it quite smart. One consequence of the smallness of the wheels was, that when a horse was harnessed to the shaft, the Bey's head, while lying down, was a foot lower than his feet, but he managed to get over this difficulty. The whole affair gave as much delight to the Bey as amusement to Captain Lyon, and will afford some proof of the scarcity of carriages in that part of Africa.

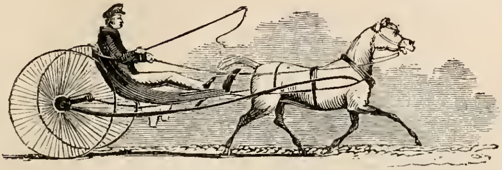
There is a kind of vehicle much in use in Russia, which, as it has a form different from everything of the kind in England, we will shortly notice. This is the *Drosky*. This is a four-wheeled carriage, of which the

Russian Travelling Carriage.

body is so near the ground, that the lower part of a rider's dress is apt to be either smothered with dust or covered with mud. It consists of very little more than a narrow bench, at the hinder part of which is a small back, about on a level with the middle of the body, and against which the rider leans sitting across the bench as if he were on horseback, with his legs hanging down on each side. In front is the driver, with his legs also across it, and separated from the person next him by a slight bar about six inches high. These vehicles, which are hired as public conveyances, as well as being the form of private vehicles, are described by English travellers as being very unsafe and disagreeable.

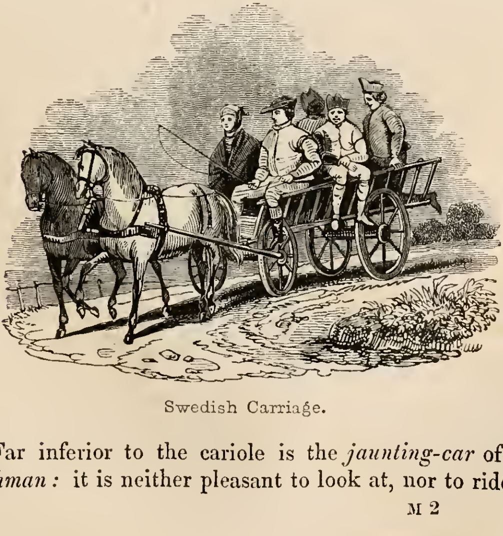
A very different looking vehicle, and one extremely light and pleasant is the *Cariole* of Sweden and Norway. The descriptions of Mr. Laing and Barrow perfectly agree ;

and from these it appears that the cariole is a little gig just large enough for one person, and resting between



Norwegian Cariole.

light wheels upon two cross-bars of wood, morticed in the shafts; they are sometimes with iron springs, but their construction is so light and elastic, that wooden springs are found very pleasant and convenient. They are made in such a simple manner that, if any accident happen on the road, the peasants, who have generally some skill in carpentry, are enabled to repair it. One of these vehicles can be purchased for four or five pounds. The other vehicle is also much in use in that part of Europe.



Swedish Carriage.

Far inferior to the cariole is the *jaunting-car* of the *Irishman:* it is neither pleasant to look at, nor to ride in.

The car is of two kinds, an *outside* car and an *inside* car, the former of which is thus described by Mr. Barrow:—"A platform or floor of a few boards has two sides which are raised up and down on hinges, raised for no other use that I can see except it be to grease the wheels. These sides are of canvas stretched on wooden frames, which drop from the edge of a seat and have a foot-board at the bottom of the frame. The backs of the two seats form a narrow *well*, as it is termed, for the stowage of luggage in the centre, a name by no means inappropriate, as it is generally full of water when it rains—and when does it not rain in Ireland? The passengers, of course, sit back to back. If a single person hires it, the driver asks, "which side of the country would your honour like to see?" and quitting his box, perches himself very much at his ease, cross-legged, on the opposite side. But my objections to them are, that they are positively dangerous, inasmuch as the legs of the passenger, being outside the wheel and totally unprotected, are liable to be struck, and and perhaps broken, through the carelessness of the driver, especially when he has posted himself as I have stated."

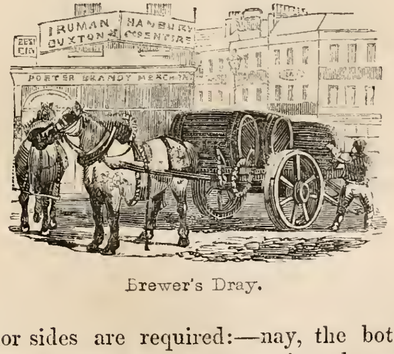
Irish Jaunting Car.

But the limits of this chapter will not permit us to conduct the reader from country to country, and show him the wheel carriages of all nations; having, presented our readers, therefore, with a view of the dashing style of the Italian vehicle, of a genteel description,

Italian Cabriolet.

we must now confine ourselves principally to "home, sweet home," and talk about English vehicles; of which there is so great a variety, from the state-coach of the monarch to the donkey-cart of the vender of vegetables, that we shall find abundance to occupy our attention.

The smallest approach to the name of a vehicle is, perhaps, shown in the Brewer's dray. Here neither



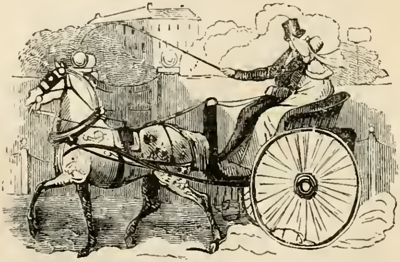
Brewer's Dray.

covering nor sides are required:—nay, the bottom itself is composed of mere bars, with openings between them.

These openings are much more fitted for the reception of the circular form of casks, than a flat uniform bottom would be, as they afford two edges against which the cask can rest. The same may be said also of the carriage used for the removal of timber.

Carts, vans, and wagons of different kinds, vary so much from one another, and are connected by such imperceptible degrees, that it is scarcely possible to separate them one from another; nor is it necessary to do so: all we have to consider with respect to them is, that the great requisite in their construction, is strength and convenience, and that elegance of form, and beauty of colour, are not so much required, or attended to.

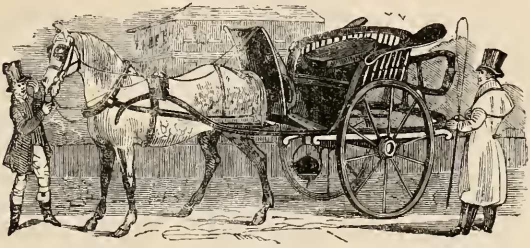
Let us take a glance at the lighter kinds of vehicles in use, that is, such as are used chiefly for purposes of pleasure. The one-horse chaise, the gig, the stanhope, the tilbury, the cabriolet, and some others, are different names for light vehicles, all having only two wheels. To the eye, and the taste of the generality of persons, the difference between them is so very gradual and trifling, that they attract not much notice; but to those versed in the matter, the points of difference are sufficiently marked. The true *gig* is not much used at present. It was very



Gig.

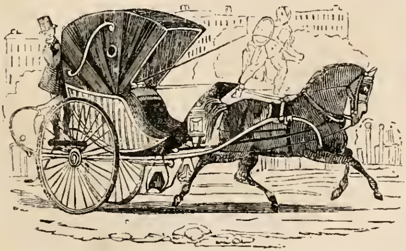
little more than a railed chair fixed upon the shafts, and supported on two side springs. It was calculated to run very easily, and the whole was well adapted for travelling purposes; a space being left under the seat to contain a portmanteau.

The stanhope and the tilbury are forms that differ very slightly from each other. The latter was named after its inventor, a coach-builder; and the former after a brother of the Earl of Harrington. The stanhope was intended as an improvement upon the tilbury. The tilbury is extremely light and airy in its appearance, but is said to be uncomfortable to the rider; a fault which does not belong, in so great a degree, to the stanhope; there are two or three varieties of the stanhopes.



Tilbury.

The cabriolet, of which the name and the vehicle are derived from the French, is a one horse-vehicle, that possesses the advantage of a covered head, which can be let down or opened at pleasure, thus protecting the rider



Cabriolet.

from rain; but not excluding fresh air. It has, generally, likewise, a foot-board behind, on which a servant can stand; a convenience which does not belong to the lighter forms of the stanhope, &c. The form of the body of the cabriolet admits of being very elegant; and the overhanging head is likewise susceptible of great variety of form. The chief objection to this vehicle seems to be, that its great weight is almost too much for a single horse.

This latter remark is exemplified by the hackney cabriolets, which ply in the streets of London. One horse is harnessed into these vehicles for the whole day, and the wear and tear which the poor animal undergoes, is often excessive, and soon brings him to a useless state.

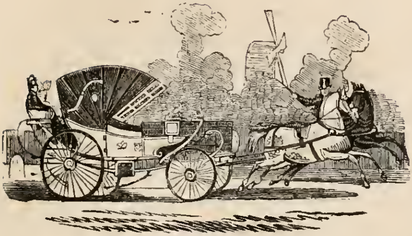
The *dennet* is a vehicle differing only in some slight respects from the cabriolet, and often used instead of it.

The *curricle* differs from all of which we have hitherto spoken, in being drawn by two horses a-breast, instead of by one; but as it only has two wheels, and, consequently, one seat, it is not necessary to describe its form.

A four-wheeled vehicle, called a *phaeton*, was very much in use some time back, and was chiefly remarkable for the great height at which the driver was perched from the ground. This excessive height, and the absence of any utility resulting from it, has led to the combination of the form of the phaeton and the cabriolet, under the name of the cabriolet-phaeton. It has four wheels, like the phaeton, but the shape of the body somewhat resembles that of the cabriolet.

A carriage called a *pony-phaeton*, has been much used by ladies. It is built low, on four wheels, and has a seat for a servant behind; and its general construction is such as to make it a safe vehicle, and, therefore, well calculated for ladies, or inexperienced drivers.

Within the last dozen years, a form of vehicle called a *britzschka*, has become very prevalent. The great conveniency of this carriage is, that the inmate can enclose himself completely from the weather, and can recline at full length. The head draws over to a considerable degree, and a screen or curtain covers, if desired, the opening which is then left; whereas, if the weather be fine, the traveller can have the vehicle as open as he pleases. In such a case it will hold four, but when closed in, only two can sit in it.



Britzschka.

We have described a Russian carriage, under the name of the *drosky*. The proper name for this vehicle is *droitzschka*, and the same name has been applied to a vehicle recently introduced into England. But it has very little resemblance to the Russian drosky, being much more like the Britzchka. The latter vehicle was introduced into England from Germany, about twelve years ago.

An open summer carriage, called a *Barouche*, was much in use before the Britzschka became known, and is still agreeable and convenient in fine weather. It is, in fact, a coach without the upper part, and is provided with a folding cover, which can be drawn over part of it in rainy weather.

All the vehicles latterly described are *open* carriages, of which it will be seen there are a great many varieties. The *close* carriages are much fewer in variety. There is the *coach*, including pleasure, stage, and mail, coaches; the *chariot*, which includes the post-chaise; and the *landau*.

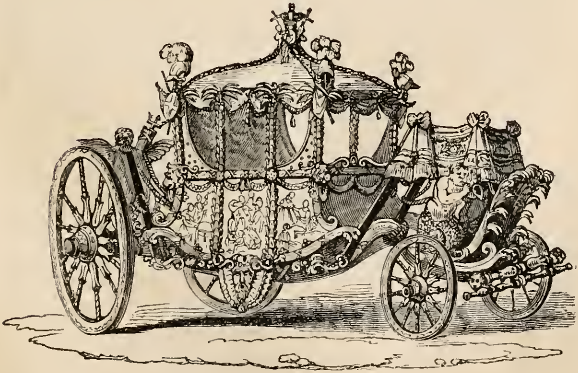
What a coach is, every one knows. It is a closed vehicle, with two seats opposite each other, each of which will hold either two or three persons; two doors, one on each side; a box in the front for a coachman; and a foot-board, for a servant, behind. These vehicles are not made to throw open overhead. A *landau* resembles a coach in form, but the upper part is made to throw open, by which the whole assumes the form of an open carriage; as is represented at the close of this chapter. The *chariot* may be said to be one-half of a coach,—the hinder half. It is a close carriage, with only one seat, and has windows in front, toward the horses. A post-chaise differs from a private chariot but little in the body; but is without a coach-box, the postilion taking his station on the back of one of the horses.

Such vehicles as we have been describing, are the usual conveyances of the wealthy in this country. Those which are used on state occasions, are more profusely decorated, and are as much intended for show, as for use. The late coronation, presented some elegant specimens of the art of coach-building: indeed "Marshal Soult's carriage," was almost as much talked of as the Marshal himself. It is evident, however, that we cannot dwell on these topics: all we can spare room for is, a few remarks on the two most splendid vehicles in England,—the "Lord Mayor's state-coach," and the "royal state-coach."

From the time when King John gave permission to the citizens of London to choose their own mayor, in 1215, it was customary for the person chosen to go to Westminster for approval; and he used to travel then on horseback: but, in 1452, the mayor, Sir John Norman, commenced the water-pageant, which has been continued to this day, the distance to the water-side being traversed on horseback. But, in 1712, a state-coach, drawn by four horses, was first used instead of the equestrian part of the pageant; and, in 1741, the number of horses was increased to six. The coach then employed is represented in some of Hogarth's pictures; and in 1757, the present state-coach was built. The expense was defrayed by a subscription among the aldermen; and the lord mayor, for every successive year, applied a certain sum to keep it in repair. It afterwards became the property of the corporation; and has had various sums expended on its repair and renovation from time to time. The coach is richly carved and gilt, the panels being painted with allegorical subjects, by Cipriani, which are now somewhat difficult to decipher. Four figures, representing the quarters of the globe, are at the four corners, and other allegorical subjects are represented in carved work.

The royal state-coach is represented in the annexed cut. This was built in 1762, five years after the city state coach. This carriage is supported by two carved cables, fastened to four *Tritons* at the corners. The framework of the body consists of eight palm-trees, which expand at the top, and support the roof; while the spaces between the palm-trees form the panels, which are glazed above and painted below. On the centre of the roof are three figures, representing England, Scotland, and Ireland, supporting the imperial crown, and other insignia of royalty. The length of the coach is about twenty-four feet, and its weight four tons, being about four hundredweight more than that of the city coach. It was designed by Sir William Chambers, and painted by Cipriani; and the following has been given as the original expense of its manufacture.

	£	s.	d.
Coachmaker, Wheelwright, &c.	1673	15	6
Carver	2504	0	0
Gilder	933	14	6
Painter	315	0	0
Laceman	737	10	7
Chaser	665	0	0
Harness-maker	385	15	0
Mercer	202	5	10
Bit-maker	99	6	0
Milliner	30	4	0
Sadler	107	13	0
Woollen-draper	4	3	6
Cover-maker	3	9	6
Total	£7,661	17	5



The Royal State Coach.

We must now bid adieu to these costly vehicles of pleasure or state, and say a few words about commercial carriages.

We have already had occasion to speak of the introduction of mail-coaches for the conveyance of letters

Mail-Coach.

From the date of their invention by Palmer, various improvements have been made from time to time in their construction, both for the convenience of passengers, and the stowage of letters, and for the rapidity of travelling. These improvements, and the excellence of the horses employed to draw them, together with certain advantages which mail-coaches have always had over others on the public roads, have had the effect of making them, for a long series of years,—indeed, until a very few years past,—faster vehicles than any public coaches; as the mails travelled at the rate of eight miles an hour, when stages were content with six. But now things are changed: ten or twelve miles an hour is not an uncommon rate of travelling by the best stage coaches. This has been brought about by superiority of construction, the employment of better horses, the improvement of roads, the desire of quick travelling on the part of those engaged in commercial pursuits, and the emulation of rival stage-coach proprietors: all have had some influence on the rate of travelling. Before the new order of things consequent on the establishment of railroads, the mail-coach conveyance, and that of stages subordinate to it, was carried in one connected chain, fron one end of Great Britain to the other,—from Falmouth in Cornwall, to Thurso in

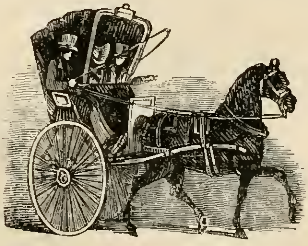
Caithness, the distance between which, taking London in the way, is considerably more than *one thousand miles*, by the most direct route. There appears reason to expect, however, that the prevalence of stage-coaches, at least for long journeys, will be much interfered with by the railroads; but if the latter yield those commercial advantages which it is supposed they will, we shall have no reason to regret their superseding stage-coaches.

Whatever may be the wishes of the majority of persons respecting the rate of the postage of letters, it is indisputable that the regulations of the general post-office, are, in many respects, superior to those of any other public establishment in the kingdom. The regularity with which letters are delivered, and the comparatively few mistakes which are made, certainly call for our approbation. The general practice has been, so to arrange the horses for the arrival of the several mails into London, that they shall reach the metropolis nearly at the same time. By this arrangement, the clerks and other persons employed at the central office in St. Martin's-le-Grand, are enabled to sort the letters from all parts of the kingdom at the same time. When this sorting is completed, and the letters are to be delivered, various contrivances have been, from time to time, made to expedite the delivery. The postmen used to receive their budget of letters at the central office, and then trudge to their several stations on foot. But they are now provided with vehicles, which are a kind of open *omnibus*, to convey them to the boundaries of their "beat," by which much time is saved. Again, in the afternoon, when the postmen have collected the letters from the various receiving-houses, they have not, as formerly, to walk to the central-office with them; but *mail-carts* are placed at certain stations to receive them, and forward them, with great rapidity, to the central office.

One of the most remarkable changes in metropolitan public conveyance, is the substitution of the *omnibus* for the *stage-coach*. A few years back, the streets of London contained few public conveyances, but hackney-coaches; those remnants of the last century,—the last resort of worn-out coach-horses. These carriages were usually the rejected vehicles of the noble and wealthy;—thus enduring, like the horses, a second and lower grade of service. Hence it is, that we often see the arms of a distinguished family painted on the door-panels of this vehicle.

Hackney-Coach.

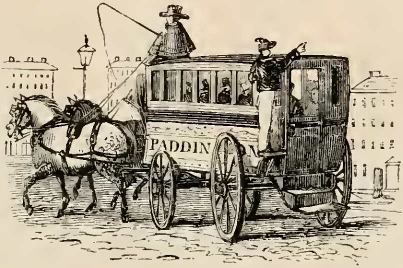
After a time, the cabriolet, or, with that clipping of words to which the English are so prone,—the "cab," was established. If one person hired a hackney-coach, he had to pay as much as if four persons rode in it; and it was principally to accommodate parties of one or two persons, that the "cab" was introduced; its slight make, and the employment of one horse instead of two, enabling the proprietor to let it at two-thirds of the fare of a hackney-coach. The kind of "cabs" which our cut represents are



Hackney-Cab.

now nearly superseded by more safe and convenient *close* vehicles, some on two wheels, and others on four, of which the forms are very various.

But a still greater change was made when vehicles performing stated and fixed journeys, were allowed to traverse the London streets. This was not much the case before the introduction of the *omnibus**. Several "short stages" used to enter London from the surrounding villages, and stop at certain fixed places, leaving the streets of London as a bounty to the hackney-coachmen. But the omnibuses have worked a great change in these respects.



Omnibus.

These vehicles were first brought over from France by a stage-coach proprietor at Paddington, who drew upon himself (as usual in such cases) the vigorous opposition of the other stage-masters, and ultimately, we believe, ruined himself by the speculation,—no uncommon thing in such cases. But it was soon found that these vehicles, clumsy as they are, possess great conveniences. The passengers can enter and alight with great ease, and without the necessity for that unpleasant and dangerous *climbing* process, necessary to mount the outside of a stage-coach. They were first used on the Paddington-road,—then on other roads near the metropolis; and ultimately, they commenced running from one end of London to the other, through the public streets. Great have been the complaints against these vehicles: many have been the fines imposed upon drivers for furious driving; and much has been said of the impudence of "cads,"—or to use a more

* This word, which is the Latin for "*for all*," probably denotes the *universal* accommodation afforded by this vehicle.

genteel word, "conductors;"—but the vast number of them now plying, and the use of them by all ranks of persons, show that the convenience of traversing London from one end to another for so small a sum as sixpence, and of entering or leaving the vehicle with so little trouble, have been sufficient to neutralize all the unfavourable circumstances connected with them.

French Diligence.

The "diligence" of France is a much heavier and more cumbrous vehicle than the stage-coach of England, and infinitely slower in its movements. The same may be said of a diligence (the only one) which runs from St. Petersburgh to Moscow. A late English traveller speaks of it in the most rueful terms; his aching bones constantly reminding him that he was not on or in an English stage-coach; and for three days and nights he could not allow himself to sleep, for fear of either knocking his luckless head against a suspicious-looking wooden bar that formed part of the coach, or of tumbling off his seat. No stage-coaches in Europe are, taken as a whole, equal in comfort to those of England.

There is a class of stage-coaches (if the term be properly applied to them), which have come much into use within a few years; we mean those employed on the various railroads. These vehicles have never to make any of those sudden turns which are required on common roads; so that it is not necessary to have the front wheels smaller than the hinder ones, but all four are of the same size. The general form of the vehicle depends upon the rank which it holds. Some are shaped nearly like private carriages, and are fitted up with nearly as much elegance; but the greater number are a kind of open omnibus, having seats, generally speaking, across the vehicle. On the "Great Western Railway," some of the carriages are of such an immense length as to require *six* wheels, and taken in conjunction with the unusually wide gauge, or width between the rails, of that railway, form perhaps the largest vehicles at present in use in England, for land travelling.

We have now enumerated as many different kinds of wheel-carriages as our limits will permit, and have offered a few remarks on most of them, of a general nature. We now proceed to say a few words on the component parts of most vehicles.

The wood of which vehicles are made, depends greatly on the purposes to which they are to be applied. Ash, beech, elm, and oak, are those of which the greatest use is made; mahogany and other fancy woods being used only for the more elegant kinds of pleasure-vehicles.

The springs form a very important part of most vehicles; since their object is to give elasticity, at the same time that they must possess considerable strength. Whatever possesses elasticity may be made subservient to the purposes of a spring, in some way or other; but the substances employed by carriage-makers are, metal, wood, whalebone, leather, and caoutchouc. Leather forms slings and braces for suspending the different parts of a carriage; whalebone is sometimes used in shafts. Wood is often used as a material for springs, to avoid a certain tax laid upon metal-spring carriages.

But steel springs are the most prevalent, and the most valuable; and the manufacture of them constitutes a distinct branch of business. The steel for this purpose is of a peculiar quality, and is rolled into sheets, from one and a half to three inches wide, for different sorts of springs. Sometimes a single plate forms a spring; but generally several are riveted together, so as to increase the power. When two or more plates have been combined, they are bent into various shapes, to suit the several purposes to which they may be applied; there is the straight spring, the elliptic-formed spring, the regular-curved spring, the reversed-curved spring, the spiral spring, and some others; springs are again distinguished by certain technical names, arising principally from the sort of vehicle to which they are generally attached, such as tilbury, mail, dennet, cabriolet, phaeton, telegraph, nut-cracker, &c. springs. Any one who inspects a number of different vehicles, will perceive how extremely diversified are the forms into which the springs are bent, according to the weight to be borne, the velocity to be attained, the shape of the body of the carriage, or the taste of the maker.

The *wheel* is a very important part of a vehicle, and has undergone numerous improvements from time to time. Not only have the solid wheels given place to those made of spokes springing from a central nave, but the form of the wheel, viewed at right angles to the line of the axis, has been changed from a flat surface to a conical, or, as it is termed, a *dish*-shape. Originally the spokes all lay in one plane, springing out at right angles from the nave; but increased strength has been obtained by *dishing* the wheels, or, making them concave on one side, and convex on the other; this is especially observable in the wheels of heavy wagons. The principal advantage of this shape is, that the space between the wheels is enlarged for the reception of the body of the carriage, and that the mud which collects on the rim of the wheel is thrown off away from the carriage, when the wheel is at the highest point of its revolution.

Hinder wheels are generally from four to five feet in diameter, and have about fourteen spokes; fore-wheels from three to four feet in diameter, with twelve spokes. A felly, or connecting piece of wood, joins the outer ends of every two contiguous spokes, and keeps them in their places. The nave of the wheel is made of elm, and the mortice-holes for the reception of the spokes are cut all round its circumference. The spokes are made of dry oak; and one end of each is fitted to the size of the mortice prepared for its reception, and driven in by a mallet. The spokes are not all driven in in the order of their position, but alternately; and are shaped to their proper form after they are fixed in their proper positions. The remote ends are then fitted into the felloes, by which a circular rim is obtained. An iron tire, or hoop, is then welded to the proper size; so that when expanded by heating, it is just large enough to encompass the wheel. As it cools, it contracts, and in the act of so doing, compresses and binds the various parts of the wheel with a prodigious force. Iron pins are afterwards driven through both tire and felloes, by which all is rendered tight and secure.

There are various causes which render wooden wheels extremely liable to get out of order; and which have led to the partial adoption of iron wheels. Wheels have been cast in iron in one solid piece. In others, the spokes have consisted of tubes arranged in a circle; in others, again, (and these may frequently be seen in London,) there are two sets of iron spokes, fixed at each extremity of the nave.

The axle-trees and other parts of a vehicle we must be content to pass over, as our limits will not permit us to enter into any details respecting these. But there is one point of considerable importance in the construction of a vehicle, and which well deserves attention; this is, how far it is necessary to have the two front wheels smaller in size than the hinder wheels.

We have said that it is for convenience of turning a corner that this disparity of size is admitted. If the front wheels could not pass under the carriage, the power of the latter to turn, or to "lock," as it is technically termed, would be but very limited; and it is almost wholly for this reason that the fore wheels have been made smaller than the hinder wheels. But this benefit is not unattended with great evils; the noise is increased, and the small wheels wear out fast, for the reason before stated; and it remains to see whether the wheels cannot be made of equal size, and yet allow the vehicle to turn.

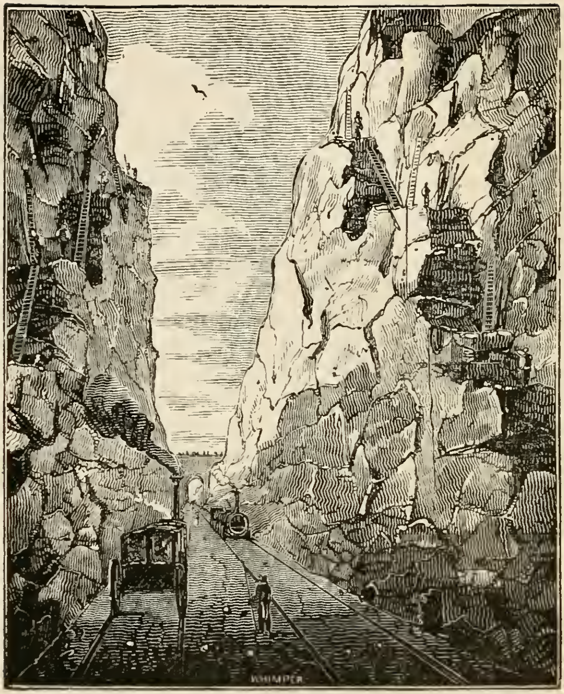
This subject has been fully treated of by Mr. Adams, in his excellent *Treatise on Pleasure-carriages;* and he has come to the decision that it would be perfectly practicable to make a pivot or bolt in the centre of the perch under a vehicle, round which pivot the whole could turn, instead of having the pivot, as at present, at the front axletree. He first studied the principles which regulate the motion of wheel-carriages, and then proceeded to put them in action.

In order to make a vehicle turn on a central pivot, not only the perch, but the body itself, must turn on a kind of hinge; and Mr. Adams proceeds to show that that may be done with vehicles of nearly all kinds. In an ordinary carriage, while the horses are in the act of turning, the face of the driver is not directed in the same way as the heads of the horses, but obliquely to them. Now, if the pivot could be placed further back than the position of the driver, it might enable him to be constantly in a line with his horses. Mr. Adams made an *equi-rotal* (or equal-wheeled) phaeton, in which the pivot was between the driver on the box, and the sitters in the body of the vehicle; it turned with greater ease than common carriages, and had the advantage of distributing the wear and tear equally among all four wheels, by having them of equal size.

He applied the same principle to an "equi-rotal droitzschka," in which the pivot was just behind the seat for the driver, and in front of the principal seat. The next application was to a close carriage, a town-chariot. Here the pivot was placed immediately in front of the body of the carriage; so that the front-wheels, the coach-box, the place for luggage, and the lamps, turned with the horses, while the hinder wheels, and the body of the vehicle, turned somewhat later.

After showing its capability of being applied to various kinds of vehicles, he proposes to apply it to *omnibuses*, of which he says, "It is jointed in the middle, where the circular sides are made flexible like a leathern head or hood. It will turn with facility in the narrowest streets, without impeding the passage-way along the interior, as the flexible sides move in a circle. With this omnibus, two horses would do the work of three; there would be great facility of access and egress; perfect command over the horses; increased ease to the passengers; greater head-room, and more perfect ventilation; greater general durability, and absence of the usual rattling noise, accompanied by entire safety against overturning. This design is calculated for the accommodation of twelve inside passengers, but it might easily be lengthened to hold twenty; and two horses would draw it with the same facility as fourteen are drawn on the present plan, on account of the height of the wheels, which so much aids the draught."

We are not prepared from our own experience to offer an opinion on this new mode of building vehicles; but the subject is certainly one of sufficient importance to require that we should have given an outline of the objection to be overcome, and the mode which Mr. Adams has proposed of overcoming it. Having done this, we must quit the subject.



Scene on the Manchester and Liverpool Rail-Road.

CHAPTER XV.

The Steam-Engine.—As applied to Sea and Land travel.—Early Attempts at Steam Locomotion.—Advantages of Rail-Roads.—Rail-Roads in the Collieries.—Wooden and Iron Rails.—Proposed Prime Movers.—Stockton and Darlington Rail-way.—Steam-Carriages and Steam-Boats compared.—Resistances to their Motion.—Skidding of Wheels.—Stationary and Locomotive Engines.

The production of the steam-engine is undoubtedly one of the greatest triumphs of modern science; whether we consider the vastness of its power, so far excelling any mechanical contrivance which had previous to its invention been discovered, or even thought of; or whether we regard this versatile agent with respect to its application to the arts, manufactures, and sea and land travel. In our own day, through the genius of Watt, and the inventive talents of other engineers, the steam-engine has become stupendous alike for its force and its flexibility,—for its prodigious power, as well as for the ease, precision, and ductility, with which such power can be varied, distributed, and applied. "The trunk of an elephant," says an eloquent writer, "that can pick up a pin, or rend an oak, is as nothing to it. It can engrave a seal, and crush masses of obdurate metal before it; draw out, without breaking, a thread as fine as gossamer; and lift up a ship of war, like a bauble, in the air. It can embroider muslin, and forge anchors, cut steel into ribands, and impel loaded vessels against the fury of the winds and waves. It would be difficult to estimate the value of the benefits which these inventions have conferred upon the country. There is no branch of industry that has not been indebted to them; and, in all the most material, they have not only widened most magnificently the field of its exertions, but multiplied a thousand-fold the amount of its productions. Our improved steam-engine has increased indefinitely the mass of human comforts and enjoyments, and rendered cheap and accessible, all over the world, the materials of wealth and prosperity. It has armed the feeble hand of man, in short, with a power to which no limits can be assigned, completed the dominion of mind over the most refractory qualities of matter, and laid a sure foundation for all those miracles of mechanic power which are to aid and reward the labours of after-generations."

But not one of the uses to which steam-power has been applied exceeds, in extent and importance, its application to *locomotion* *, connecting, as it does, the most distant points of the country, and promoting that facility of intercourse which of all improvements is the greatest; since, by bringing the different parts of a country together, its strength is increased, and that unity of action and in-

* Motion from place to place.

telligence ensured, which brings all, even the most remote and widely scattered districts, into the way of improvement, both moral and mental. It was an important era in the history of civilization, when, about forty years ago, steam was first applied to navigation; the remarkable facilities which this application afforded to trade and general intercourse, and the great changes it has actually effected, and is still effecting, in our commercial and social relations with other countries, are appreciated by all. Previous to this discovery, navigation was impeded, and its utility vastly curtailed, by the uncertain and often opposing actions of wind and waves, which often made a voyage of a few miles a matter of toil, uncertainty, and delay. Rivers and other great inlets of the sea were of little or no advantage to commerce, and the grand benefits which we generally associate with the very name of *river* were then scarcely known, because no craft could ply constantly on any of the great streams, when they could proceed with certainty in one direction only. As an example of the mutilation and imperfection of water-communications in all countries before the application of steam to navigation, the writer of an able article on this subject, in the *Quarterly Review*, mentions that "on the great river Mississippi which flows at the rate of five or six miles an hour, it was the practice of a certain class of boatmen, who brought down the produce of the interior to New Orleans, to break up their boats, sell the timber, and then return home slowly by land; and a voyage up the river from New Orleans to Pittsburgh, a distance of about 2000 miles could hardly be accomplished, with the most laborious efforts, within a period of four months." But now, mark the change:—the influence of wind and tide, when opposing, is defied; when influencing, it is allowed to co-operate with and assist the new agent, whose available power seems limitable only by the strength of the material which confines it; yet is it perfectly manageable, and acts with equal efficacy against, as well as with, the current: so that voyages that once baffled the navigator, and embarrassed commerce, are now performed with all the certainty and celerity of land-journeys. The rapid rivers, on whose surface a solitary ferry-boat was heretofore only occasionally seen, are now crowded with ships, bearing the produce and the intelligence of all climes, to distribute among, to benefit, and to enlighten, the inhabitants of the shores of those rivers, whose opposing waters had so long prevented the entrance of those blessings. Steam-boats are now plying on all the great rivers of the civilized world, and rapidly diminishing that portion of it which we call *uncivilized.* The four months' journey above alluded to, from New Orleans to Pittsburgh, is now easily performed in about fifteen days. Steam-vessels have long plied on the Ganges, and other great rivers of the east. The rivers, lakes, inlets, and narrow seas of Europe have long since made acquaintance with this admirable invention. The intercourse between Britain and Ireland, between Britain, France, Germany, and even America, is now carried on by steam-boats, thus tending to make the several people of several climes better acquainted, and tending to promote that peaceful union of art, science, and intellect, with love, good-will, and peace, which, more than aught besides, will tend to beat "swords into ploughshares and spears into pruning hooks: nation shall not lift up sword against nation, neither shall they learn war any more." Is. ii. 4. The promise, "that the Gospel shall be preached among all nations," seems to be more and more on the point of perfect fulfilment, at the present time, when the Almighty seems to have so far favoured the inventive talents of man, in enabling him to contrive and improve means for international intercourse, and that facility of communication among the individual members of the whole human family, whereby, we should hope, Christianity and civilization would be, hand in hand, everywhere diffused.

It is probable that the first successful performance of a steam-boat suggested the important problem, how far the same power could be employed in impelling carriages by land. So early as the year 1769, Mr. Watt, in his original patent for his improved steam-engine, mentions its applicability to domestic improvement,—a suggestion made to him by Professor Robison, although Watt does not seem even to have imparted motion to a carriage by steam. Symington, also, who had so much to do with the original invention of steam-boats, contrived a steam-arrangement for propelling carriages; and is said to have exhibited in 1787, in Edinburgh, the first model of a steam-carriage that had yet been seen. From this time the attempts were numerous, but for many years unsuccessful; not so much from want of skill, but from the existence of some radical difficulty, which was long insurmountable.

The cause of these failures was probably the great weight of the engines, and the resistance to the motion of the carriages by the inequalities of the roads. In the steam-boat this difficulty did not exist, since a large amount of weight is buoyed up by the water, without adding much resistance to the motion of the vessel, but every additional weight to a land-carriage produces additional resistance, arising from inertia, friction, and such like impediments, in proportion to its weight. The undulating nature of our roads, too, presented insuperable obstacles; and even though the line of road could be exactly levelled, yet the softness of the materials would allow the wheels of the ponderous machines to sink; and even if this difficulty were obviated, the roughness and irregularity of road-making materials present a series of elevations and depressions, on which the wheels on advancing are continually rising and falling. It is the incessant lifting of the whole mass of the carriage over these protuberances, which occasions that drag which is felt even on the best roads. In order, therefore, for steam-carriages to move on common roads, it would be necessary, *first*, to make them level, or nearly so; and *secondly*, to make them harder and smoother than they now are.

In order, therefore, to apply steam with success to the general purposes of land-travel, it was necessary to make a new and improved species of road, such as would be free from all the obstructions of common roads. Thus, it is generally supposed, originated the *rail-way* or *rail-road*, now so extensively adopted in this country; but the fact is that railways had been in use, as we shall presently see, long before steam-power was applied to locomotion.

The rail-road has this grand advantage over the common road, that, for the soft and unequal surface of the latter, there is substituted a smooth, hard surface of wood, or more commonly of metal, fixed in two narrow tracks along which wheels of carriages roll with an ease and a velocity, as much exceeding the effect of the most perfect modern road, as the latter exceeds the worst roads of olden time. These tracks, or rails, were at one time made of wood, but now iron is the material universally employed. They are laid in lengths of from four to sixteen feet, united firmly together by joints at their extremities, and resting at every two or three feet on a heavy block of stone, fixed firmly in the ground. There is, of course, a track of these rails for each wheel throughout the line; and the two tracks together form what is called a *single line* of railway. But it is most usual to have another line running parallel with the first, and placed at a few feet distance from it, for the purpose of allowing carriages moving in opposite directions to pass each other without interference: this is called a *double line*. In some cases, where the traffic is considerable, a third or a fourth line is laid down, with communications between them at intervals, to enable one carriage moving in the same direction, but with greater velocity than another, to pass it by moving on to a separate line, without either of them stopping. A third line of rail-way is also useful, in case one of the others should be undergoing repair.

Such, then, is a brief, but sufficient introductory description of a modern rail-road, which we will suppose preserves a horizontal position throughout the whole of its line. The inexperienced reader may now think a rail-road to be a very simple affair, and wonder not only that its construction should be of so modern an origin, but that so many men of first-rate science and ingenuity should devote their high powers to what would seem so easy and practicable. In answer to this, we must remind him that simplicity is one of the noblest features

N 2

in the results of a great mind: the works of the Almighty, when we thoroughly understand them, are found no less simple, than beautiful and effective; complication always bespeaks weakness, and a want of that mature knowledge, which, with small means, accomplishes great ends. But simple as the execution of a rail-way may appear, it is an expensive and difficult undertaking, requiring for its full effect, an advanced state of knowledge of the arts and sciences. Indeed, the difficulties of rail-road travel are perhaps known only to the engineer and the practical philosopher. What seems so easy to an ordinary observer, has been the result of much costly expenditure, of much high intelligence, and is yet capable of vast improvement. When we regard the ponderous machine with carriages attached to it, containing hundreds of human beings, and thousands of tons of goods, moving with a velocity of thirty miles an hour, exciting the wonder and admiration of spectators, we are too apt to applaud injudiciously, and to think we have attained perfection in locomotion. But what is the sober truth? However calculated the performances of modern locomotive engines may be to excite our admiration, yet it cannot be denied that they are still awkward and cumbrous, not only in their form and application, but also in their performances. The art of constructing them is still in its very infancy; and on so recent an occasion as the completion of the Liverpool and Manchester rail-road, the Company thought seriously of erecting large steam-engines at different points of the line, to pull the carriages from station to station, the engines themselves being fixed; so great was the want of experience nine years ago, in the construction of locomotive engines! We shall speak more in detail on this subject hereafter; but we think it right to warn the reader thus early, to refer any disparaging observations he may meet with, to the right source; for the present chapter is written with the full feeling and assurance, that great as are and have been the benefits of rail-roads and locomotive engines, they are but as the rippling of the waters of a becalmed sea, waiting for the exertion of those mighty influences which shall excite it to action, and produce those tidal waves, whose influence the whole world shall feel and acknowledge.

The first railways were of wood, and the earliest account of their introduction occurs in the account of the life of the Lord Keeper North, wherein it appears that about the year 1670, they were employed at Newcastle-upon-Tyne, for transporting coals from the mines to the barges in the river Tyne; in which service, even at that time, when the demand for coals was so limited, nearly five hundred carts were constantly employed. It became, therefore, an important object to reduce the expense of maintaining so many horses, carters, and roads, as these conveyances required; and the plan of wooden rails was the best method which at that time could have been adopted. The situation too was favourable, since it presented, for the most part, an easy descent towards the river. These roads soon became generally introduced in the coal districts. Strips of ground of the required length were laid out between the mouths of the coal-pits and the river, and were leased to the coal-owners, or purchased by them of the land-owners, through whose property the road extended. The line of road was varied in its direction, so as to meet the unevenness of the ground, and thereby to obtain an easier and more regular descent; in some cases, embankments and cuttings were made, and a regular slope obtained. The ground being thus prepared and smoothed, large logs of wood, called *sleepers*, cut in lengths equal to the breadth of the road, were fixed across it, and embedded firmly at short intervals, to which the wooden rails were fixed, on which the wheels of the carriages were to run. These rails were generally formed of beech, and were placed end to end, so as to form two parallel lines, one for each wheel; the ends of these rails being secured to the wooden sleepers, which served as foundations. The coal-wagons were of large size, with small wheels, the smoothness of the road rendering high wheels unnecessary. An ordinary horse drew three tons of coal on this road without difficulty. When a more than usually steep descent occurred, it was called a *run;* and the too rapid descent of the wagons was prevented by a species of crooked lever, or brake, called a *convoy*, attached to the wagon and regulated by the driver. Along the steep banks of the Tyne, the railway was continued on a wooden stage, raised to the height of the top bank of the river, and carried forward until it came over the river side, where a wooden platform, called a *staith*, was erected for the purpose of delivering the coals through shoots or spouts directly into the holds of ships moored underneath, or into a store below, from which the ships might afterwards be conveniently loaded.

The defect of these rails arose from the decaying nature of the substance composing them, and the expense of maintaining them in repair greatly detracted from their value. They were much improved by fixing flat bars of iron to their surfaces; but the grand improvement of all consisted in forming the rails altogether of iron, and substituting stone sleepers for those of wood. The first construction of iron rails is said to have originated in a curious circumstance. The proprietors of the Colebrook Dale Iron Works first determined to cover their wooden rails with cast-iron, not that they thought to improve the rails thereby, but they hoped that, if their plan were generally adopted, the sale of iron, in which they were so much interested, would be promoted. "But it happened some time after that the price of pigs* became very low, and their works being of great extent, in order to keep the furnaces on, they thought it would be the best means of stocking their pigs to lay them on the wooden railways, as it would help to pay the interest of expenses by reducing the repairs of the rails; and if iron should take any sudden rise, there was nothing to do but to take them up and send them away as pigs." This is the account of the first adoption of iron rails, about the year 1767, as given by Hornblower to a committee of the House of Commons on the subject of roads and carriages.

The first substitution of iron for wooden rails was attended with some inconveniences; the resistance or adhesion to the surface in descending inclined planes was so much

* "Pigs of iron" are masses of the metal, of a certain form and weight, as delivered from the foundry to the workers in iron.

reduced, that the ordinary brake was found quite insufficient to oppose the descent. This led to a very admirable improvement; double, or self-acting, inclined planes were invented, by which the surplus force of gravity, in the case of a load descending one plane, was employed to draw up the empty wagons on the ascending plane. This plan was found efficient, and was soon extensively adopted in all the collieries of the North of England.

The reader is so apt to associate rail-roads with steam, that in what is emphatically called *the rail-road*, he includes generally not only a level road laid out with iron rails, but also a number of carriages propelled by means of a locomotive steam-engine. But a rail-road is not less a rail-road, if the prime mover be *animal* power instead of steam. Indeed, we have just seen how the *force of gravity* is made to act as a prime mover when inclined planes are employed, and it has even been proposed that an extensive line of road shall be made to consist of a series of ascents and descents. In such case, if a carriage were started from one of the elevated points, it would descend by its own weight alone, and acquire sufficient momentum to mount part of the adjoining ascent; if, therefore, a small propelling power were added to the force of gravity, the acquired momentum would be sufficient to bear the carriage to the summit of the ascent; and thus, by a series of descents and ascents, a journey of any extent is proposed to be made; such is the *undulating railway*. Another proposal has been to employ *compressed air* as a prime mover, as also *carbonic acid gas* in the act of liberation from a solid carbonate (marble, for example) by the action of an acid. Indeed, Sir Humphry Davy did not think it beneath him to bestow a portion of his attention on *liquid* carbonic acid as a prime mover. This substance exists in the liquid state only under very intense pressure; as soon as the pressure is removed or relieved, the liquid bursts into its gaseous form with amazing force; and it was thought that, by allowing small portions of the liquid to escape from pressure, the expansive force might be converted into a prime mover. Another projector has directed attention to what he calls a *pneumatic railway*, where a long cylinder is employed containing air rarefied by means of stationary steam-engines. The carriages are to move along the upper surface of the cylinder; and the front carriage is connected with a piston working air-tight within the cylinder, there being rarefied air before it, and air of the common pressure behind it, by which it is propelled forward. A combination of *electro-magnetic* actions is also looked forward to as a prime mover.

Some of these proposals, and many more tending to the same end, are calculated to excite a smile; but it is necessary to be cautious how we smile, since most of these projects proceed from ingenious and thinking men, and we have a full tide of experience to assure us that plans now in extensive use, whose success is beneficially experienced by every one, were subject in their infancy to all the derision which startling novelty is calculated to excite. As the dominion of mind over the most refractory qualities of matter becomes more complete, we shall find the feeble arm of man furnished with new powers, of which we can now scarcely form an idea. Some of the above proposals for prime movers are, perhaps, in the present state of our knowledge, utterly impracticable; but our children, or our children's children, may live to see much of our art and science freed from the many imperfections which, to a great extent, are inseparable from humanity: but, as the grand truth becomes more and more fully impressed upon us, that the progress of science is not less ensured by the search after error than by the search after truth, in order to eradicate the one and extend the other, it is not too much to say that great and mighty changes, bearing with them, we should hope, all the blessings of vast improvements, are on the eve of consummation; and it is only the consciousness that this world is but a scene of preparation for a better, that checks the rising regret of the Christian philosopher, that he has been born too soon to participate in that more perfect state of knowledge, which to his ardent fancy appears to be dawning upon the world.

In the year 1825, the Stockton and Darlington railway was opened, at which animal power was the prime mover employed for propelling the carriages. This line was calculated to show the wonderful superiority of rail-roads over the very best common roads. A carriage containing six passengers inside and from fifteen to twenty outside, with a due proportion of luggage, was constantly drawn by a single horse at the rate of ten miles per hour, without more exertion to the animal than if the draught had been that of a small gig on a common road. The coach was not mounted on springs, and yet the motion was perfectly easy. The coach was not made to turn on the railway, but was drawn backwards and forwards, the horse being unyoked from one side and yoked to the other. Such was the ease with which the loaded vehicle moved, that it was not possible for the coachman to "pull up," as he calls it, without the assistance of a brake attached to the wheels. The cheapness of this mode of travelling was not its least recommendation; the fare outside between Stockton and Darlington, a distance of twelve miles, was one shilling, and for shorter distances at the rate of one penny for each mile. The inside fares were exactly one half more.

These illustrations are calculated to remind us of the advantages of the rail-road over common roads. The rail-road enables us, even in its present imperfect state, to increase the power of draught more than ten times, and even with horses alone to travel with extraordinary speed and economy. These effects arise from the superior hardness and smoothness of the metallic surface compared with the common road, so that the carriage-wheels roll without the usual impediments to their motion. Even on common roads, the grand desiderata are those very two qualities which so much recommend the rail-road. A horse will perform one-third more work upon a clean road than upon one which is slightly muddy; more than four times as much as upon newly-spread gravel, and almost seven times as much as upon a heavy sandy road. These, then, are the advantages of hard smooth common roads compared with such as are soft and uneven. The comparison of the best constructed common roads with rail-roads is yet more instructive. It appears, from experiments made by Mr. Wood, with a well-constructed model, that the whole of the resistance to the motion of a carriage on a well-constructed railway is capable of being reduced to the five hundredth part of the weight to be drawn. If, therefore, we estimate the power of draught of a common cart-horse through a day's work at 150 pounds, moving at the rate of two and a-half miles an hour, we shall find the same horse competent to draw on a well-constructed rail-road (500×150) 75,000 pounds, or about $33\frac{1}{2}$ tons, at the same rate. This is supposing a perfection of workmanship in the rail-road which in practice is not attained; but, from the great improvements which are being yearly effected, it is more than probable that a single horse will be capable at some future time of drawing at least 20 tons.

The resistance to the motion of a carriage on a well-constructed rail-road is exceedingly small compared with what a steam-boat has to encounter in moving through its fluid support. Many persons are in the habit of expressing surprise that while a steam locomotive engine moves at the rate of thirty miles an hour, the utmost speed of a steam-boat does not exceed ten or twelve miles an hour. Let us consider this question with respect to the two modes of conveyance, and the reader will see that a comparison between them in point of speed is unfair.

The resistance to the motion of a heavy body is its *weight*, or, in other words, the action of gravity upon it; to overcome which force, a greater force must be employed; and this, in the cases before us, is the elasticity of steam. But the question is not how the body is set in motion; but what are the impediments which retard that motion when once begun, supposing the moving force to be constant. These are friction and adhesion: also the resistance of the air through which the locomotive engine moves; and of air and water through which the steam-boat moves. Now, with respect to friction and adhesion, we may resolve them into one; since, generally speaking, the first is produced by the second. Friction may be defined as the rubbing of the parts of engines or machines against each other, whereby much of their effect is destroyed. A body upon a horizontal plane would be capable of motion by the application of the smallest amount of force, were it not that the contiguous surfaces are more or less rough, and the points of contact always more or less irregular in form. Now, attraction, or adhesion, operates with a varying amount of force; and extraneous bodies such as dust, moisture, &c., intervene. To overcome these impediments, a far greater amount of force is necessary, than if a perfectly round and smooth body were to be moved over a perfectly smooth and horizontal plane. Adhesion is but a modified example of the grand and universal principle of gravity, which governs and regulates all matter. As the planetary bodies exert a mutual attraction for each other, so the smaller masses of matter upon this earth exhibit effects of the same law. Now, it has been proved by scientific men that adhesion is greater between the surfaces of bodies of the same material, than between those of different materials. This adhesive force is greater, for example, between two similar metals, than between two of different kinds. It is greater between any two metals than between metal and wood, or between metal and stone. It follows, therefore, that the metal wheels of locomotive engines have a greater adhesion with the iron rails, than if the wheels moved on a turnpike-road. But the power required to set a steam-carriage in motion is first employed to overcome the inertia of the weight: this being done, the friction continues the same throughout; for it has been found by experiment, that this impediment is not increased by the motion of the bodies themselves, however rapid this motion may be. The next impediment, *viz.*, the atmosphere, is, with respect to any velocity hitherto attained, of comparatively less import*. But how different is the case of the steam-boat! The water, it is true, supports upon its surface the most enor-

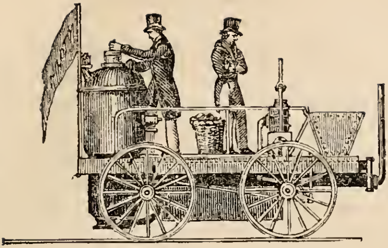
* The subject of atmospheric resistance upon railways is, at the present time, engaging the attention of eminent engineers, with the view of determining the ratio of the resistance to the velocity.

mous weights with admirable effect; and seems to remove every impediment to their motion, except the mere inertia of matter; so great is the ease with which they can be moved about with only a slight force. The man who descends in the diving-bell to construct submarine foundations, or to recover the treasures of a wrecked ship, appears as if endowed with giant strength; he can lift blocks of stone, or pull up sunken cannon, as if they were deprived of their distinguishing ponderosity. Such is the effect of fluid support. We have already seen the advantages of canals, when the slow pace of two miles an hour is preserved; but let us attempt to accelerate that motion, and we shall soon experience the resistance of the dense medium to such a degree, that however great may be the amount of impelling power, whether a gigantic steam-engine, or the most capacious sails swelled by the most favouring breeze, a limit of speed is soon attained, beyond which it is impossible to advance. The power of the engines of many steam-boats is equal to that of two or three hundred horses; and yet ten or twelve miles an hour is the maximum speed; because the water through which the boat moves offers a resistance which constantly increases with the velocity of the vessel itself, and soon counterpoises any increase of power which may be intended to counteract it. But, on a railway, the several resistances cannot be said to increase with the velocity: they are for the most part diminished; because, time being an element in all the operations of nature, the more we diminish the time, the more we escape the operation of all retarding forces.

The reader must not, however, suppose that the resistances which tend to diminish the effect of machinery, act always with injurious effect. We have seen that when, on a railway, the iron tire of the wheel is in contact with the iron rail, adhesion is greatest, because there are two metals of the same kind in contact: this adhesive force, while it tends to oppose any change of mutual contact, also retards the horizontal passage of the lowermost point of the wheel along the plane of the rail; and this latter retardation is of so great an advantage, that although it may appear at first sight as a defect, yet without it the railroad would be shorn of much of its value. To understand this subject, we must request the reader to follow us through a few details. When a carriage is drawn in the usual way by a horse, the road, upon which the wheels move, acts as a fixed point, which offers a certain resistance to the circumference of the wheels; and these necessarily revolve on their axle as the carriage advances: all that is necessary being that the resistance on the road shall exceed that at the axle. But, if the moving power be within the carriage itself, and its effort be to turn the wheel on its axle by means of a pin or handle attached to a spoke of the wheel between the centre and the circumference, then, if the face of the wheel and the surface of the rail be quite smooth and free from friction, the wheel will slide round, or slip upon the road during its revolutions; and the carriage must, in consequence, remain perfectly stationary. This is called the *skidding* of the wheels. If, however, the pressure of the tire of the wheel upon the rail be such as to produce adhesion between them, to such an extent as to prevent skidding, the wheel can then only turn round by causing the carriage to advance: the wheel then rolls upon the rail, and the carriage moves through a space equal to the circumference of the wheel during every one of its revolutions. In practice, it is found that sufficient adhesion is produced to prevent skidding; but, in the early attempts at locomotion by steam, the inconvenience of this skidding was rather anticipated than felt; and hence arose many ingenious contrivances and inventions, which a little practical experience would have shown were quite unnecessary. A few of these we will briefly detail.

Two different modes have been proposed for propelling carriages on railways by the force of steam. *First*, to draw the carriages along on the rails by ropes or chains attached to stationary engines, placed at short distances along the road. *Secondly*, by means of a portable engine capable of imparting motion to the wheels which bear it. The first of these proposals would be the more difficult, or rather the more expensive; and the second was certainly the more desirable in every respect, when once such an engine was invented, and found to be practicable: but this plan had its difficulties: for it was necessary to produce an engine on a new construction, essentially differing from the stationary engines employed to work machinery. The objects to be attained were lightness and compactness, which were of secondary consequence in fixed engines; but became matters of first-rate importance in locomotives. It was necessary to dispense with all the cumbrous apparatus of the cold-water cistern, the condenser, the various pumps, and the weighty beam and fly-wheel, whose motions in the fixed engine act with such tremendous effect. All these were to be rejected; and the light and simple locomotive engine was to depend solely for its force and effect upon the elasticity of *high-pressure* steam. Such an engine was made; and in the early engines provision was also made for preventing the skidding of the wheels. Teeth or cogs fitting into each other, like those of a rack and pinion, were cut both in wheels and rails: but this plan was soon abandoned; for the motion was rough, jolting, and noisy; and the wear and tear immense. Propellers were then attempted: these consisted of jointed poles, projecting from the back of the engine, and imitating on a large scale the motions of a horse's hinder legs. The engine thus pushed itself along, as a person in a boat may do by thrusting a pole or oar against the bed of a river. But it was ultimately found that all these contrivances were unnecessary; for, after all, as we have before stated, the difficulty was imaginary; the friction being quite sufficient to prevent skidding, however smooth the rails might be. Since this time locomotive engines have been the subjects of constant improvement: the speed of forty miles an hour is not uncommon; and the consumption of fuel has gone on gradually diminishing.

But enough of RAILROADS in general. Let us now contemplate the details of that mighty power; that triumph of ingenuity; that emblem of peace and national prosperity,—the STEAM ENGINE!



The Novelty Steam Locomotive.

CHAPTER XVI.

On the Steam-Engine in general, and as applied to locomotion in particular.—Steam; its elasticity; how estimated.—The Steam-Engine; its general construction.—The Atmospheric Steam-Engine.—The high-pressure Steam-Engine.—The low-pressure or condensing Steam-Engine.—Watt's improvements.—The principal details of a Steam-Engine.—A Locomotive Steam-Engine described.—Steam-Locomotion on Common Roads.

When we are travelling by a stage-coach at the rate of eight or ten miles an hour, we can understand the nature of the force which sets the vehicle in motion: we understand in a general way the nature of animal power: we see how soon it is exhausted; every successive hour do we watch the panting and reeking animals to their stalls, and, in the course of a day's journey, we can appreciate the enormous succession of efforts required to transport a loaded vehicle from London to a distant town.

But, when proceeding on a journey by the rail-road, we are seldom allowed to get a sight of the wondrous power which draws us so rapidly along. The scene is altogether changed; there are no animals yoked to the car, to excite our pity by their apparently short, but really severe labour; we hear the steam gushing from the safety-valve, while the machine is for a short time stationary; then we hear a number of rapid beatings: we feel that we are moving; the motion soon increases rapidly, and the journey which by the stage-coach is so tedious, is here, long before we are aware of it, at an end. The traveller then wonders, not only at the rapidity of his journey, but often wishes to inspect and comprehend the means by which it was effected; he is not allowed to go up to the engine to examine it; and if he were, he would probably be little the wiser. He has, therefore, as yet only obtained hasty glimpses of the locomotive, as it whirled rapidly by or under the spot where he has stood to gaze upon it; he knows nothing, but desires to know something, of the application of steam-power to locomotion.

It is for such a reader as this that the present chapter, and indeed the present volume, is written: we propose to take a view of the steam-engine in general, and of its application to locomotion in particular, sufficient to convey to the general reader a clear notion of the power employed in rail-road travel.

The vapour arising from water boiling in an open vessel is always equal in elasticity or pressure to the atmospheric air; that is, it exerts a pressure of about fifteen pounds on every square inch of surface exposed to it; and if the column of mercury in a barometer were sustained by the pressure of such vapour, instead of the atmosphere, it would stand at the same height; that is, the length of the column of mercury would equal about thirty inches. But, if water be boiled in a close vessel, such as a steam-boiler, the force or elasticity of its vapour will go on continually increasing; because, since there is no outlet whereby the vapour can escape, as it is formed, it necessarily becomes more and more compressed; and unless the pressure of this vapour against the interior sides of the boiler be relieved, they will eventually burst out with a tremendous explosion. This is the cause of the fearful accidents produced by the bursting of steam-boilers; examples of which are unfortunately too common. Now, in order to measure the elastic force of steam in a boiler, we employ a bent tube called a *barometer-gauge.* This tube is open at both ends, which point upwards; one end communicates with the interior of the boiler, and the other end is left exposed to the air; but all communication between the steam in the boiler, and the air without, is prevented by a quantity of mercury occupying the bend of the tube, and rising a short way up its upright branches. It follows, therefore, that if the steam in the boiler be equal in elasticity to that of the air, the pressure in both legs of the tube will be equal, and the mercury will remain at the same level in both. But, if the steam in the boiler exceed in elastic force the external air, the mercury in the steam-leg will be depressed, while that in the air-leg will be elevated. The steam is then called *high-pressure steam.* If, on the contrary, the elasticity of the steam in the boiler be less than that of the external air, there will be a partial vacuum within the boiler, the air without will have a tendency to enter it, and will depress the mercury in the leg exposed to its pressure, and elevate it in the steam-leg. The steam is then called *low-pressure steam.* High-pressure steam of course exerts a pressure of more than fifteen pounds on every square inch of surface exposed to its action, and supports a barometric column of mercury more than thirty inches in height; but low-pressure steam exerts a force of less than fifteen pounds on the square inch, and does not support so high a column of mercury. The force, elasticity, or pressure of steam is, therefore, estimated either by the number of inches of mercury which it will support; or by the number of pounds pressure which it exerts on a square inch of surface.

Sometimes very highly elastic steam (such as is employed in the steam-gun of Mr. Perkins) is estimated at a certain number of atmospheres: that is to say, the steam exerts a pressure so many times as great as that exerted by the atmosphere. Thus, steam of five atmospheres signifies steam that is capable of supporting a barometric column, 5 times 30, or 150 inches high, and which exerts a pressure on every square inch of 5 times 15, or 75 pounds.

With these preliminary remarks we proceed to delineate the principal features of the *steam-engine.*

The most important part of the steam-engine is the cylinder, a round upright case of iron, closed at both ends, except a small circular opening in the centre of the top, through which an iron rod passes, bearing at its lower end a solid plug, or piston, which fits so accurately as to prevent all communication between the upper and lower parts of the cylinder, but at the same time moves easily up and down within it. Now the object of all the other mechanism of the steam-engine, is to move this piston with a forcible, regular, and alternate up-and-down stroke. This is effected by causing the spaces above and below the piston to be filled with fluids of different densities or elastic forces; so that when the elastic force of the upper fluid predominates, the piston is forced down, and when the lower fluid is the more elastic, the piston is forced up. The force of the stroke, which constitutes the power of the engine, will of course depend conjointly on the superficial area of the piston; and on the difference of density in the two fluids above and below it.

All the various modes of working the steam-engine may probably be resolved into three general principles, each of which we will briefly detail.

I. The Atmospheric Steam-Engine first brought into practical operation by Newcomen in 1705. In this engine the cylinder was open at the top, and at the bottom was a tube passing to the boiler, which, however, was prevented from communicating therewith, unless by the opening of a cock or valve. Suppose now that the piston is resting at the bottom of the cylinder, and that this cock is opened; the steam will rush up from the boiler, and lift the piston up to the top of its stroke; the steam-cock is then shut by an attendant, and another cock called the *injection-cock*, opening into the side of the cylinder, is opened, whereby a jet of cold water is admitted from a cistern above, which is always kept full by a pump worked by the engine. This cold water immediately condenses all the steam in the cylinder, and produces a vacuum below the piston. The exterior air then acts with its full force of fifteen pounds per square-inch on the upper surface of the piston, and forces it down to the bottom, ready to be again lifted up, as soon as the attendant has opened the cock to let up the steam from below. The up-and-down motion of the piston was communicated by a long rod to one end of a large beam, poised in the middle like a see-saw; and to the other end of this beam was appended the rod of a pump for draining a mine; which was the office which the steam-engine at that time performed. The atmospheric steam-engine has long been out of use.

The circumstance of this machine requiring an attendant for the purpose of opening and closing the valves, led to a singular, and at the same time, a truly valuable invention. A boy named Humphrey Potter was appointed to attend the engine, and soon growing weary of the monotonous task of continually turning the cocks backwards and forwards for hours together, he contrived, by a combination of rods and strings, to make the engine work its own valves. The boy, whose name has been immortalized for perhaps the most useful act of his life, is spoken of by several writers on the steam-engine as "an *idle* boy, whose invention was one of the resources of idleness;" but this is unjust; this poor and uneducated peasant had evidently a mind superior to the mechanical and wearying task allotted to it; and his invention, which has continued to the present day, was one of the resources of his genius, which education and study would doubtless have made valuable both to himself and to his country. Invention is *never* a result of idleness; but it is the result of an active and original mind; there are hundreds of improvers to one inventor; the former require talent, the latter genius; and we think that Humphrey Potter possessed both.

II. THE HIGH-PRESSURE STEAM-ENGINE is now principally employed in the propulsion of locomotive carriages, in preference to the low-pressure engine, the arrangements of which are too numerous and complicated, and occupy too much space for carriages. The former kind of engine is by far the most simple. A rude approach to it was invented by Leupold in 1720, and applied in an improved form to locomotion by Trevithick and Vivian in 1804. In this form of engine, both ends of the cylinder are closed; and one department consists of a steam-tight iron box called a *valve-box*, from whence branch four passages; one leading into the boiler, another into the chimney, a third to the top, and a fourth to the bottom of the cylinder. In this box is a contrivance called a *sliding-*

valve, which is moved by the engine. When the piston is at the bottom of its stroke, a communication is opened between the boiler and the bottom of the cylinder; and also between the top of the cylinder and the chimney. The steam, therefore, rushes from the boiler into the lower part of the cylinder; and as it is high-pressure steam, it predominates over the pressure of the air, and thrusts up the piston: at the same time, the steam or air above the piston is driven out through the chimney into the open air. But this same upward stroke of the piston alters the position of the sliding-valve; so as to make the bottom of the cylinder communicate with the external air, and to allow the steam from the boiler to be admitted at the top of the cylinder, whereby the piston is pushed down ready for another up-stroke. There are many modes used for producing this alternate passage of the steam to and from the top and bottom of the cylinder. We will describe one mode, which we prefer on account of its simplicity; although it is by no means the best; it is called the *four-way cock.*

Fig. 1.

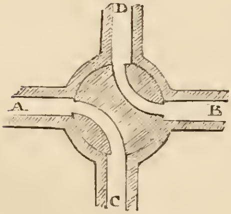
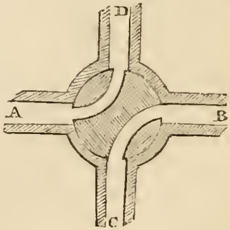


Fig. 2.

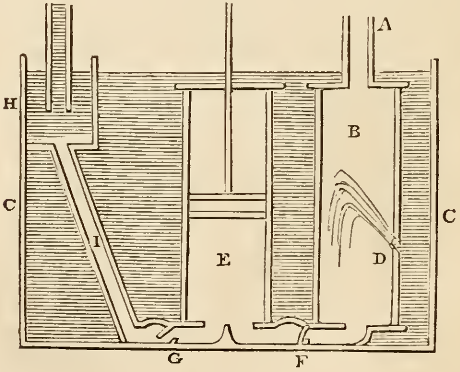


In each figure let A represent the induction-pipe, or that by which the steam enters from the boiler; B the eduction-pipe, or that which conducts to the chimney; and C and D the passages to the bottom and top of the cylinder respectively. During the upward stroke of the piston, the cock, which is a round plug having two passages bored through it, is in the position of fig. 1, where A communicates with C; and D with B; as we have just described; but, during the down stroke, the cock is placed in the position shown in fig. 2, and a reverse action ensues. It will readily be seen, by an inspection of the figures, that the cock or plug has only to be moved round one quarter, that is through an arc of 90°, to effect this great change; and this motion can easily be imparted to it by means of a bent lever connected with the piston-rod, or with the working-beam of the engine.

III. In the engine just described high-pressure steam only can be employed; because it has to overcome the pressure of the air, before it can move the piston, which is forced up and down only by the difference of force between the steam on one side and the air on the other. But in the Low-pressure, or rather the Condensing Engine, steam is on one side of the piston, and a vacuum on the other: the steam therefore acts with its full force, and it matters not what kind of steam is employed, whether high or low pressure. This is the form of engine now universally used for propelling machinery, and generally for moving ships. It was the offspring of the fine genius of Watt, whose object was to retain and combine all the advantages of the two engines just described, and yet to avoid those disadvantages which to a certain extent seem inseparable from them. The first defect of Newcomen's form of engine, was the necessary cooling of the cylinder produced by the injection-water at every down-stroke. Unless the cylinder be kept as hot as the steam which enters it, a great deal of steam will always be condensed, and an immense waste of heat, and, consequently, of fuel, will result from this alternate heating and cooling. To remedy this defect, Watt drew off the steam during the down-stroke into a separate vessel, where it was condensed. This vessel was kept constantly cold, and the cylinder constantly hot: so that by this simple and elegant invention a vast saving of fuel was the immediate result.

There was yet another great defect in Newcomen's engine. This was the cooling produced by the great mass of cold air, which entered the cylinder from the top at every down-stroke. To obviate this, Watt closed the top of the cylinder, and forced the piston down, not by air, but by hot steam, let in above the piston; and during the up-stroke, this steam was drawn off and condensed, as the lower steam had been before. The engine now assumed a new character: its action was quite independent of the atmosphere, and for the first time could it really and truly be called a STEAM-engine; for it was now moved solely by the direct force of steam. This form of engine is called *double-acting*, in contradistinction to the *single-acting* engine in which the piston is acted on during its down-stroke only; it being returned to the top by a counterweight at the other end of the beam. To understand the general mechanism of this engine, let us first imagine an engine like the high-pressure engine already described, except that the last passage conducting from the valve-box or fourway-cock, instead of leading to the chimney, leads into a cylindrical vessel called the *condenser*, represented at B in the following figure.

Fig. 3.



This vessel, as well as the rest of the apparatus about to be described, is kept cold by immersion in the cistern of cold water CC, which is kept always full by a pump (not shown in the figure) worked by the engine itself. During the down-stroke of the piston, the steam below it is forced into the condenser; and during the up-stroke the same result is obtained for the steam above the piston.

At the same time the injection-valve D is opened by a rod connected with it, and a jet of cold water is let in to condense the steam. But the condenser would thus become soon full of hot water, by the mixture of the condensed steam with the injection-water. The mixed contents of the condenser consisting of hot water, uncondensed steam and air are, therefore, all drawn off at every stroke, by the air-pump E placed by the side of the condenser. This pump is constructed in two different modes; we will describe the simpler of the two. It consists of a hollow cylinder, having a solid piston fitting tight, which derives its motion from the great beam by means of an attached rod. This cylinder is closed at the top, through which the rod works air-tight; but at the bottom there are two passages F and G furnished each with a valve. When the air-pump piston is elevated, a partial vacuum is formed in the space below it; and the air, water, and steam, in the condenser B, open the valve F and rush into the air-pump cylinder, the piston of which then falls and drives them out through the valve G. They cannot, of course, escape by the way they entered, because the valve F opens inwards: they are, therefore, forced up the tube I into a small cistern H, called the *hot well*, from which the hot water is pumped up by another pump into a cistern above, ready to descend, when wanted, into the boiler by means of a self-feeding and self-adjusting apparatus. All these three pumps, for hot water, cold water, and air, are worked by rods connected with the working-beam. To the further end of this beam is hung a long stout rod, the lower end of which turns a crank on the main axle, which, after passing through a wall from the engine-house into the apartments, sets in motion any sort of machinery.

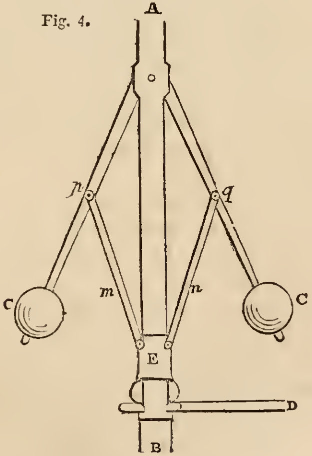
In contemplating these and other beautiful arrangements, (with which every Englishman ought to be acquainted; since the steam-engine has been a grand source of wealth and prosperity to his country,) and seeing the tranquil readiness with which this engine supplies itself, as it were, in its own wants and necessities, we can scarcely reject the idea that it is a creature endowed with life, sense, and intelligence, exerting its gigantic powers for the good of man with untiring perseverance; promptly performing labours which to ourselves would be slow and toilsome, and perhaps impossible. The subject of the present volume does not allow us to linger over the details of this wondrous machine, beyond a sketch of its principal features; but if what we have already written and have yet to write on the subject, should excite the interest of any of our readers, they are earnestly advised to study the subject in detail: they will find the steam-engine of Watt, with its subsequent improvements, to contain a vast fund of knowledge of the most valuable complexion.

Another important improvement of Watt is what is called *working expansively*. In the ordinary mode of working the engine, the induction-valve is left open during the whole of the piston's stroke, until the cylinder is filled with steam equal in density to that in the boiler. But, by working expansively, the induction-valve is closed after the piston has descended part of its stroke, and it is forced through the remaining part simply by the expansion of the steam in the cylinder, which is quite cut off from communication with that in the boiler. Thus the required quantity of steam, of heat, and consequently of fuel, is greatly diminished; and this alteration, trivial as it may seem, has thus been productive of great benefit.

A vast number of contrivances have been made by Watt and others, for economizing fuel and labour, and for rendering the engine more and more independent, and self-supplying. This it is which gives the modern steam-engine much of its apparent intricacy. We can only find space to describe one or two of these arrangements, and we will, therefore, speak of the means whereby the machine is made to regulate the force and rapidity of its action.

On the main axle is fixed a large cast-iron wheel, sometimes thirty feet in diameter, called a *fly-wheel*. Its rim is extremely thick, so as to throw the weight thereof as much as possible to the circumference. The inertia of so large a mass of metal spread over so large a surface, renders it difficult either to set it in motion, or to accelerate its motion; and its momentum, when once called forth, renders it equally difficult to arrest or retard its motion. These properties give it a remarkably equalizing power: for, when once fairly set going, it has so great a tendency to go on in one uniform state of motion, that all the little variations and irregularities in the velocity of the machine, are, as it were, absorbed and neutralized, so as to produce no sensible effect. Even were the formation of steam to stop for a short time, the want of this prime mover would not be felt, because the momentum of the fly-wheel would continue to bear it round with apparently undiminished velocity. This simple regulator is not, however, found sufficient of itself; and there is introduced in all stationary engines another contrivance called a *governor*. This consists of an upright axle A B connected with some rapidly revolving part of the machinery.

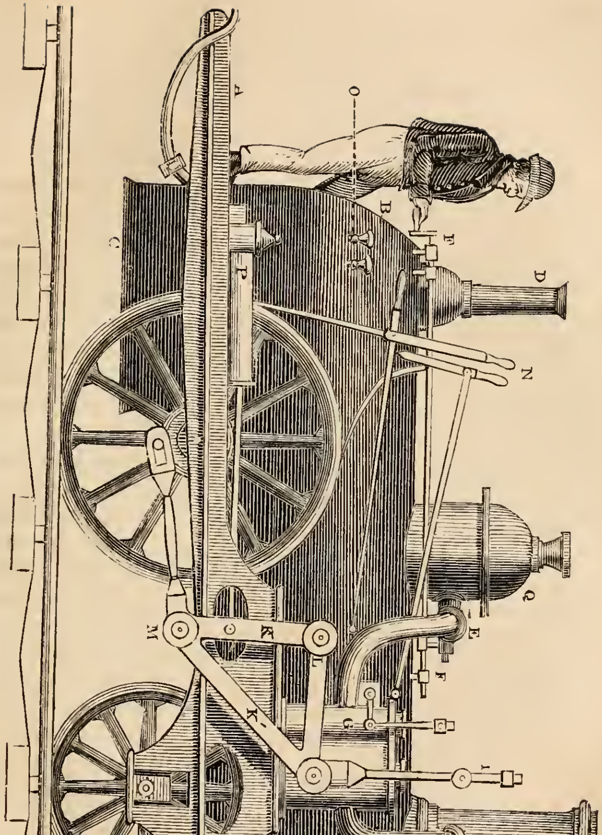
Fig. 4.



In the upper part of this axle is a fixed collar, to which are hung by joints the pendulums C C, of which there are two and sometimes four. These are furnished with balls of brass or iron; which, when the engine is at rest, hang down and touch the upright axle: but when the axle A B revolves, they fly out (as represented in the figure) by virtue of their centrifugal force; and the more rapidly they revolve the greater becomes this force, and the greater becomes their distance from their centre of motion. Each of these arms or pendulums has attached to it at *p q*, a link or bar of iron *m n*, and the two or four links all meet in a moveable ring, or collar E, which slides up and down the axle. Now, when the engine is working too rapidly, the balls C C fly out, and lift up the collar E above its usual position: this elevates one end of a long lever D, the other end of which partially closes the throttle-valve, diminishes the supply of steam from the boiler to the cylinder, and thus retards the speed of the engine. But if, on the contrary, the balls and collar, owing to an insufficient velocity, sink, the collar depresses the lever, the throttle-valve is opened wider, and the supply of steam and consequent velocity of the engine is increased.

We stated in the last chapter that lightness and compactness were the grand desiderata in a locomotive engine, and yet that it depended for its power upon the elastic force of high-pressure steam. Let us now inquire into the arrangements of this form of engine, referring the reader to the accompanying figure, which represents an approved form of railway locomotive.

We observe a strong cast-iron frame, A A, supported on four wheels, of which the two hinder and larger are are called the *driving-wheels*. On this carriage rests the boiler, B B, which is cylindrical in form, and is made of plates of wrought-iron. The furnace, or stove, is at the hinder end, and the chimney in front. The former is a cubical iron box, the lower part of which is seen at C; its sides and top are double, enclosing between them a layer of water about three inches thick, which is constantly replenished by water descending from the boiler; for, as the top of the stove is rather below the level of the water in the boiler, this layer of water is always preserved of the same thickness, and the steam as it is generated passes up into the boiler. The smoke and hot air from the fire escape into a number of small tubes (of which there are about ninety) which completely traverse the lower half of



The Locomotive Steam Engine.

the boiler on their way to the chimney. So that nearly all the heat, smoke, and hot air, from the furnace is turned to the useful purpose of assisting to heat the water; and the draught is increased by the waste steam being projected up the chimney. Any pieces of ignited fuel, which may be carried up with the draught, are prevented from escaping into the air, and doing mischief, by a wire-net capping on the top of the chimney. At E is the *throttle-valve*, which is moved by the engineer by means of a long rod F F, so as to regulate the supply of steam, and consequently the speed of the engine. From this valve the steam passes by a large tube into the valve-box G, and thence into the top or bottom of the cylinder to work the piston; it then escapes by the pipe H, into the chimney. The cylinder in this engine preserves its usual upright position, but in other engines almost every variety of situation and position has been tried for it; it has been placed horizontal, sloping, and vertical, with the piston-rod pointing in various directions. Of course, all the apparatus shown in our figure on one side only of the boiler is repeated on the other side; so that there are, in fact, two engines, one for each driving-wheel. Each piston-rod I, bears at the top a cross-piece, from which hangs a rod connected by a joint at the lower end to one corner of the moveable iron triangle K K′, whose centre of motion is at L; to the other corner of this triangle is joined the rod M, which, by means of a crank, works the wheel. The action of the triangular frame K K′, is similar to that of the brass quadrants used at the corners of rooms to alter the direction of the bell-wire; it converts the vertical motion of the piston-rod at one corner into a horizontal motion at the other corner.

The water and fuel are carried behind in the first carriage, which is called the *tender*, and the water is drawn through the *feed-pipe* by means of the horizontal pump P, which is worked by having its rod attached to the triangle at K.

At N are the handles of two levers, by which the course of the steam may be so altered as to reverse the action of the engines, and consequently of the wheels, so as to move the engine backwards or forwards, at pleasure.

The following is the simplest species of sliding-valves, and is free from the objections which pertain to the four-way cock. Each of these figures represents a section of

Fig. 6.

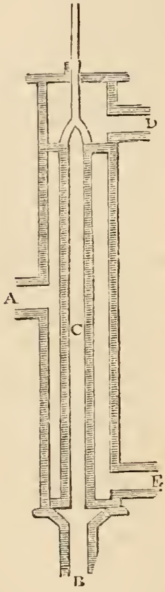
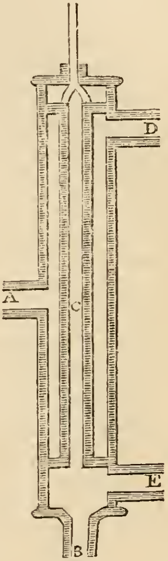


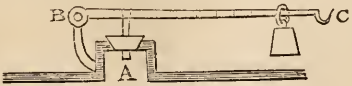
Fig. 7.



the valve-box, consisting of a cylindrical tube, rather longer than the cylinder of the engine, and having within it a smaller tube C, which slides up and down by a rod passing out at the top; near each end of this tube is a projecting rim, or collar, which fits air-tight in the larger tube. The passage A is connected with the boiler; D leads to the top, and E to the bottom, of the cylinder: B is the eduction-pipe, leading to the condenser in a condensing engine, and to the chimney in a locomotive or high-pressure engine. This last opening may be either at the top or bottom of the valve-box, as they communicate through the small tube C. Fig. 6, represents the position of this tube during the down-stroke. The steam from the boiler passes round on either side of the small tube C, and enters the engine at E, below the piston, to force it up, while the steam above it returns to the valve-box by D, descends the tube C, and passes out at the chimney. But, during the up-stroke, the tube C is in the position shown in fig. 7, whereby the steam from the boiler passes through D, above the piston, forcing it down, while the steam below it passes out through E, and escapes by the eduction-pipe B. As this valve-box is usually placed close by the side of the cylinder, and sometimes cast in one piece with it, its rod may be moved up and down by the piston-rod:—thus the rod of the valve-box may be prolonged upwards, and have two flat disks attached to it, the distance between them being rather less than the stroke of the engine; the piston-rod has also a horizontal arm projecting from it: when it comes to the bottom of its stroke, this arm strikes upon the lower disk on the rod of the sliding-valve, and thus pushes it down into the position of fig. 6; and when the piston-rod is at the top of its stroke, the arm strikes against the upper disk and thrusts the valve up again into the position shown in fig. 7.

In our figure of a railway locomotive there are a few very useful appendages, which, although we have reserved a notice of them for this part of our subject, are by no means peculiar to locomotive engines. The barometer-gauge has been already described; but, although this contrivance shows exactly the elastic force of the steam, it furnishes no means for regulating that force, or protecting the boiler from explosion. Both these purposes are served by that invaluable contrivance the *safety-valve*, whose origin and use bear a much earlier date than the steam-engine. It consists of a plug fitting into a small hole in the boiler, as at A in the annexed figure, and attached by an upright stem to a kind of steelyard, which

Fig. 8.



moves on a hinge at B, and bears on its arm (which is graduated into a number of parts) a weight made to slide backwards and forwards, so as to press the valve down with any required force. When different weights are used, they are hung on the hook C. Now if the plug, or valve A, have a superficial area on its under surface of two inches, and the engineer wish the steam to attain a force of twenty pounds on the square-inch, he so adjusts the weight on the graduated arm C B, as to press down the plug with a force of forty pounds, or twenty pounds for each inch; and so long as the elasticity of the steam does not exceed that limit it will not open the valve. When, however, it does attain that degree of elasticity, it will force open the valve by lifting up the weight, and a portion of steam will go on escaping until the density of the remaining portion is reduced to a pressure of twenty pounds per inch*. The value of this arrangement is, that if the valve be not loaded above the pressure which the boiler will bear, there is no danger of bursting. Sometimes, in very low-pressure engines, there is danger of the boiler being crushed in by the external pressure of the air, owing to the partial vacuum within; to obviate this, internal safety-valves are contrived, so that, should the elasticity of the enclosed steam become too low, a portion of air is admitted, which increases its density.

The locomotive engine described above has no internal safety-valve, because *high*-pressure steam is alone employed, but it has two external safety-valves. One has a moveable weight, and is enclosed under the case D, and can be regulated by the engineer, to enable him, within certain limits, to direct the force of the engine and the velocity of its motion. But the engineer might occasionally be ambitious to proceed at a rate far beyond his usual speed, and this he can only do by increasing the elasticity of his prime mover—the steam in the boiler—and loading

* This is, in Mechanics, a specimen of a lever of the *third* kind, where the power is at A, the fulcrum at B, and the resistance at C. In this sort of lever, power is most disadvantageously employed; and, in this instance, great must be the power of the steam at A, to raise the loaded bar B C.

the valve accordingly; there would then be danger of the boiler bursting. To prevent such a catastrophe, another valve, with a fixed weight attached, is provided under the case Q, the cover of which is firmly bolted down, but contains holes for the escape of the steam. This valve, therefore, being inaccessible to the engineer, will prevent danger, however much he may overload the other valve at D.

The two small cocks, represented at O, are called *gauge-cocks;* their use is to show the height of the water in the boiler. They communicate with two small tubes within the boiler which turn downwards, and are not quite equal to each other in length; so that one reaches just below, and the other just above, what ought to be the level of the water. If the water be at its proper level, these cocks, on being opened, will discharge, the one water and the other steam. But if they both discharge water, the boiler is too full; if they both discharge steam, it is not full enough; the engineer, therefore, acts accordingly.

In the lower part of the same figure is shown the latest improvement in the construction of the rails. They are supported at short intervals by sleepers, or square blocks, of granite, let into the ground. Each rail is made of an inverted arch form between the sleepers.

The application of steam to locomotion on common roads, is an art yet in its very infancy. It was practised by Trevithick and Vivian at the beginning of the present century; but their success was small, and they had recourse to a railway. Since that time steam-carriages have been made and successfully applied by Messrs. Ogle, Hancock, Gurney, and others. Mr. Gurney constructed, in 1831, a steam-carriage which plied between Gloucester and Cheltenham regularly for four months, like a common coach. These attempts were soon abandoned on account of the excessive tolls demanded by the turnpike-trusts, the opposition of interested parties, and the prejudice of the public generally. Mr. Gurney petitioned Parliament on the subject, a committee was appointed to investigate the matter, and a very favourable report resulted, which concluded with the following summary:

"Sufficient evidence has been adduced to convince your Committee, 1. That carriages can be propelled by steam on common roads at an average rate of ten miles per hour. 2. That at this rate they have conveyed upwards of fourteen passengers. 3. That their weight, including engines, fuel, water, and attendants, may be under three tons. 4. That they can ascend and descend hills of considerable inclination with facility and safety. 5. That they are perfectly safe for passengers. 6. That they are not (or need not be, if properly constructed) nuisances to the public. 7. That they will become a speedier and cheaper mode of conveyance than carriages drawn by horses. 8. That, as they admit of greater width of tire than other carriages, and as the roads are not acted on so injuriously as by the feet of horses in common draught, such carriages will cause less wear of roads than coaches drawn by horses. 9. That rates of toll have been imposed on steam-carriages, which would prohibit their being used on several lines of road, were such charges permitted to remain unaltered."

The principal obstacles to the introduction of locomotive carriages, on common roads, were considered to be the weight of these carriages themselves, and the mode of propulsion, which no common road would be able to bear for any length of time without great injury. In the above Report, the Committee state that, however strong their conviction may be of the comparatively small injury which properly-constructed steam-carriages will do to the roads, yet this conviction is founded more on theory, and perhaps what may be considered as interested evidence, than practical experience; they therefore recommend that the House should not make, at that time, any permanent regulations in favour of steam. The experience of a few years would enable the legislature to form a more correct judgment of the effect of steam-carriages on common roads. They therefore recommend that the tolls imposed on steam-carriages by local acts, where they shall be unfavourable to steam, be suspended during three years, and that in lieu thereof, the trustees shall be permitted to charge toll according to a rate agreed on by the committee.

It was not anticipated by the Committee, that steam would be used as a propelling power on common roads for heavy wagons. It seemed to be the general opinion of witnesses that, in proportion as the velocity of travelling by steam on common roads is diminished, the advantages of steam over horse-power are lost. The efficiency of horses in draught is rapidly diminished as their speed is increased; while on the contrary, the weight which could be carried or propelled at any great velocity, by steam, could not be more cheaply conveyed were the speed decreased to that of the slowest wagon. Indeed, Mr. Gurney considers that, under four miles per hour, horses can be used in draught more economically than steam.

From other parts of this report it appears that the greatest speed attained by Mr. Ogle's carriage amounted to between thirty-two and thirty-five miles an hour; that it has attained sixteen and a-half miles an hour on a slope rising one in six; that thirty-six persons have been in one carriage; and that it has drawn five times its own weight at from five to six miles an hour. Steam-carriages have been lately made by Mr. Hancock and Mr. Gurney, exactly resembling in shape an omnibus, a stage-coach, a britschka, and even a gig. The chief merits and differences in the carriages of these gentlemen consist in their boilers and fires. In Gurney's the bars of the grate are made hollow and contain water. The construction of his boiler is shown in the following side and front views of it. It consists of two cylindrical vessels A and B, placed in front of the fire, and above them is the vessel C called the *separator;* this latter vessel alone contains steam, the others being full of water. These three vessels communicate by means of the passages D D D D, and from the back of the lower vessel A proceed twelve tubes which serve as a grate for the fire; one of these is seen at E, fig. 10. Below them, at F, is the ash-pit. After traversing the back of the fire-box, they arrive at the vessel B, as seen in the side-view. The flame and smoke play round and between these tubes, and vaporize very rapidly the water in them. The steam, as it is formed, passes up into the separator C, and its place is supplied by cold water descending through the passages D D. Thus a very quick circulation is regularly kept up. The chimney is at G, and the opening of the main steam-pipe at H.

Fig 9.

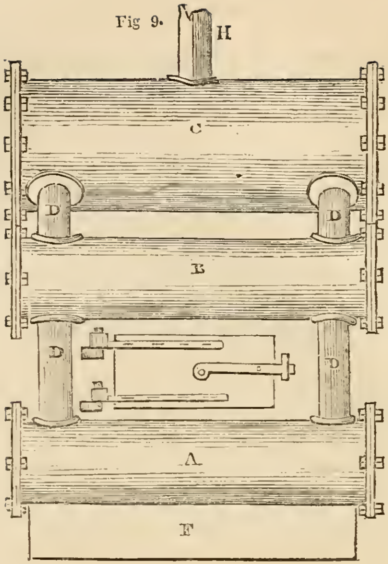
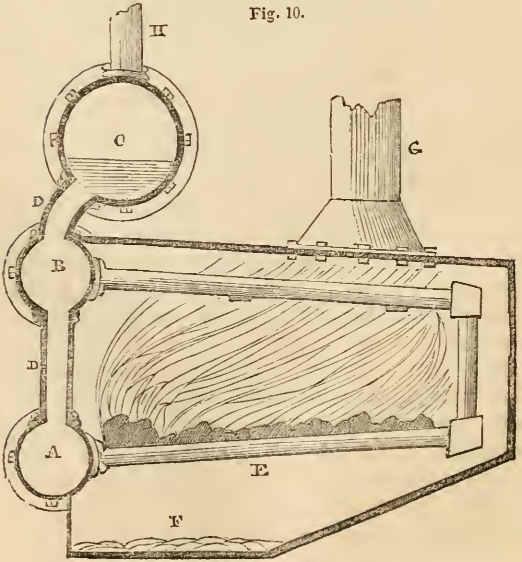
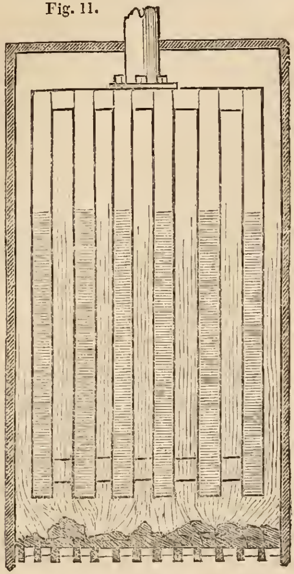


Fig. 10.



In Hancock's boilers the water is contained between a number of upright plates of iron, as in the following lateral view. The water is thus distributed into thin

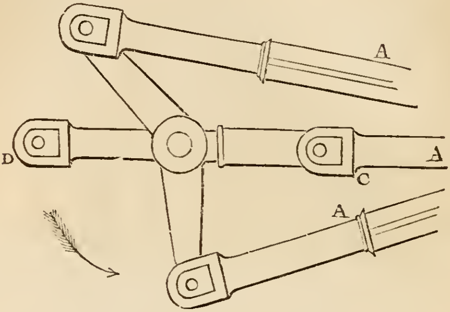
Fig. 11.



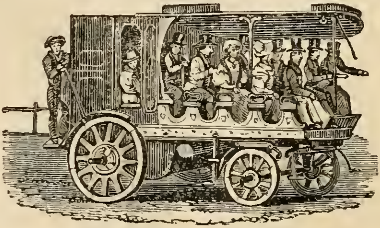
sheets, between which the flame and smoke pass up from the fire below to the chimney. The plates are connected together by tubes at the bottom and top, the former for the water and the latter for the steam.

In all steam-carriages, either for rail-roads or common roads, and in almost all steam-packets there are two distinct engines working two cranks on the main axles, which bear the driving-wheels in carriages, and the paddle-wheels in vessels. The chief object of this is to obviate a defect in the crank, which we will explain. Let the following figure represent a crank with its rod in different parts of its revolution. When the crank is at B, supposing it to revolve in the direction indicated by the arrow, the rod is exerting its full force to pull it round; and when it is at the opposite point the rod will be acting on it in a similar manner. But it is obvious that there are two parts of its revolution, where neither direct pulling nor pushing will tend to make it revolve; these are the

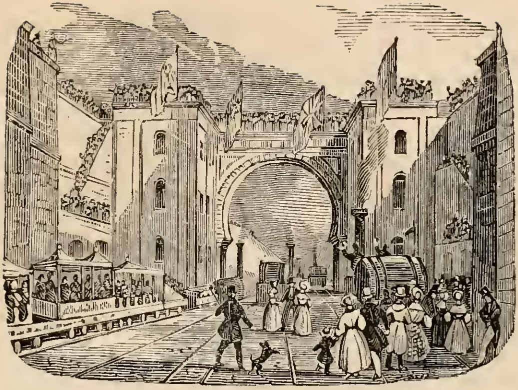
Fig. 12.



points C and D, called the *dead points*, at which, when the crank has arrived, it is carried past them simply by its momentum, for the rod has as much tendency to pull in one way as the other. When *two* cranks, therefore, are placed on the same axle, they are set at right angles to each other, so that the *weak* or *dead points* of the one may correspond with the *strongest* points of the other. There is, of course, a difference of half a stroke between the two engines, to accommodate them to this arrangement; one engine is always half a stroke later than the other: so that there is no danger of both the cranks arriving at once at the dead points. If this were to happen, the motion would not only be uneven, but the cranks would probably be broken off short.



Locomotive Carriage.



Opening of the Liverpool and Manchester Rail-road.

CHAPTER XVII.

The Liverpool and Manchester Rail-road.—Necessity for the undertaking.—Plan and estimate of the Line.—Edge-hill Tunnel.—Sankey Viaduct.—Chat-moss.—Laying the Rails.—Passage of the first Locomotive over part of the Line.—Prize offered by the Company for the best form of Locomotive Engine.—Adjudication of the Prize.—Opening of the Road.—Accident to Mr. Huskisson.—Commencement of Traffic.

To the reader who is interested in the subject of rail-roads generally, we cannot offer a more instructive and admirable specimen of this mode of conveyance, than that which connects the two great towns of Liverpool and Manchester. Whether we regard the perseverance of the spirited individuals, who projected, and after much opposition obtained parliamentary permission for, the undertaking; or whether we consider the gigantic nature of the work, and the natural difficulties, the removal of which would have appeared to require more than human skill and power; the final triumph over all of them; and the success of this grand experiment, which for the first time excited the wonder and admiration of a whole nation at the marvellous power of steam thus applied; in whatever light we consider the Manchester and Liverpool railway, admiration and gratitude must be the most prominent emotions which it is calculated to excite.

The necessity for an easy and prompt means of communication between Liverpool and Manchester, had long been desirable, not only as a local, but as a national benefit. Liverpool is the port from which Manchester procures all her raw materials, and to which she returns vast quantities of manufactured goods for exportation. Before the construction of the railway, heavy goods had to be first sent up the Mersey to Runcorn, a distance of about twenty miles; and thence by one of the two canals to Manchester; thus making the distance between the two towns fifty miles. In warm weather there was frequently a deficiency of water, in consequence of evaporation, and boats could only go half-loaded; and in cold weather the navigation was often impeded, or suspended, for weeks together by ice; to say nothing of the effects arising from tempestuous and contrary winds, which often arrested the progress of the vessels in the Mersey. The average length of time for the passage was thirty-six hours; but, from the operation of impediments such as those just cited, goods have been known to be longer on the way by water from Liverpool to Manchester, than from New York to Liverpool!

It will serve as a useful antithesis to these examples, to state that the transit of goods is now effected in about two hours, which is about one-eighteenth part of the average time previously occupied by the water-conveyance, besides a saving of fifty per cent. in the cost per ton of carriage; producing an annual saving in carriage to the cotton manufacturers of £20,000, and rendering it unnecessary for them to keep a large stock in hand to supply sudden orders.

In 1824, the following plain statement of the inconveniences of these delays and difficulties was made by Mr. James. "Notwithstanding all the accommodation canals can offer, the delays are such, that the spinners and dealers are frequently obliged to cart cotton on the public high-road, a distance of thirty-six miles, for which they pay four times the price which would be charged by a railroad, and they are three times as long in getting it to hand. The same observation applies to manufactured goods, which are sent by land-carriage daily, and for which the rate paid is five times that which they would be subject to by the rail-road. This enormous sacrifice is made for two reasons:—sometimes because conveyance by water cannot be promptly obtained, but more frequently because speed and certainty, as to delivery, are of the very first importance."

About the same time, a declaration, embodying the sentiments of the above passage, was signed by more than one hundred and fifty of the most respectable merchants of Liverpool, who expressed the general feeling, "that a new line of conveyance has become absolutely necessary, to conduct the increasing trade of the country with speed, certainty, and economy."

It was, therefore, determined to form a company for the construction of a double railway between the two towns. This was done, and a prospectus issued in October 1824. In the following February, parliament was petitioned for leave to bring in a bill, which, however, was soon lost, chiefly through the powerful opposition of the proprietors of the canals in the vicinity of the proposed line. Early in 1826 a second bill was introduced, and passed into a law.

So gigantic and difficult did this work appear to be, that it was declared, in evidence given before parliament, to be impossible; and some of the opponents of the first bill stated that, from considerations of kindness to the promoters of so wild and impracticable a scheme, the bill ought to be rejected. Let us now consider the nature of the difficulties which were to be overcome, and trace briefly the progress of the works which were begun in the year 1827.

The turnpike-road between Manchester and Liverpool measured thirty-four miles; but, proceeding in nearly a straight direction, the proposed line of railway would measure only thirty-one miles. At Liverpool the docks are sixty-six feet below the level of Manchester; but in the vicinity of the former place the land rises one hundred and sixty-nine feet above the docks: and the surface of the land between the two towns alternates considerably; the highest point being two hundred and five feet above the docks, and the lowest twenty-six feet. Now the whole line, passing through this ground, was to be made as level as possible; and to avoid interfering with the town of Liverpool, it was determined to cut a tunnel under it. The length of this tunnel is 1970 yards; and in some places it had to be carried through solid rock. In several parts of the line a perfect level could not be obtained; so that many ascending and descending inclinations occur; the particulars of which may be seen in the following statement:—

The Tunnel, from Wapping to Edge-hill, being an inclined plane whose length is - - - -	1970	yards	with a rise of	$\frac{1}{48}$
Level by cutting - - - -	1000	—		
Edge-hill to Wavertree to Hayton - - - - - - - - -	$5\frac{1}{8}$	miles	with a fall of	$\frac{1}{1092}$
Wiston inclined plane - -	$1\frac{1}{2}$	—	rise	$\frac{1}{96}$
Rain-hill level - - - - - -	$1\frac{7}{8}$	—		
Sutton inclined plane - -	$1\frac{1}{2}$	—	fall	$\frac{1}{96}$
Parr-Moss to Sankey canal and viaduct - - - - - - - -	$2\frac{1}{2}$	—	—	$\frac{1}{2640}$
Sankey Viaduct to Bury-lane	$6\frac{1}{2}$	—	—	$\frac{1}{880}$
Chat-Moss - - - - - - -	$5\frac{1}{2}$	—	rise	$\frac{1}{1200}$
Baston, Eccles, Munches levels - - - - - - - - - - -	$4\frac{1}{2}$	—		

These inclinations were, of course, only allowed to exist in order to save expense and labour: but much of both was required; as, indeed, may be supposed, when we state that among other works sixty-three bridges were to be constructed; cuttings to the extent of nearly twenty-seven millions of cubic yards; and embankments to the amount of two hundred and seventy-seven thousand cubic yards to be made; which, with tunnelling and other works, "presented a charge," as a modern writer remarks, "which none but British merchants could have ventured to have undertaken, and perhaps only British engineers could have executed."

The tunnel under Liverpool, which we have already noticed briefly in our chapter on TUNNELS, was constructed in about eight separate lengths, each communicating with the surface above by means of perpendicular shafts. During the year 1827, this work was carried on with untiring industry. The excavation proceeded night and day; and the difficulties, which constantly arose, were very great: sometimes a soft blue slate with quantities of water appeared; and at other times wet sand, which required to be supported with much masonic skill. In one part a large mass of moist earth and sand fell in, and choked up the tunnel. Sometimes these formidable obstacles alarmed the miners, and they refused to work; and it required much personal encouragement, on the part of the engineer, to keep them to their posts. However, difficulties did not always occur: they sometimes met with a fine red sandstone easily cut through, and so substantial as to require no props, and no arching of masonry for support. In June 1828, it was reported to the directors that the tunnel was nearly completed. The appearance of this tunnel is singular and picturesque: it being whitewashed throughout, and lighted with gas. The roof and sides, near each gas-burner, are so strongly illuminated, that the whole vista appears like a succession of superb arches formed through massive parallel walls, the intervening spaces being left in comparative obscurity.

Sankey Viaduct.

In 1828 preparations were made for the erection of the great viaduct over the Sankey valley. About two hundred piles, from twenty to thirty feet long, were driven firmly into the foundation-site of each of the ten piers. The Sankey viaduct is shown in the last figure. It is a massive, but handsome structure, consisting of nine arches, each having a span of fifty feet: the height of the viaduct is seventy feet above the Sankey canal; a lock of which is shown in the figure. The structure is chiefly of brick, with stone facings: the breadth of the railway between the parapets is twenty-five feet.

One of the most difficult parts of this line was that over Chat-Moss, a huge bog, comprising an area of twelve square-miles, so soft as to yield to the foot of man or beast; and in many parts so fluid, that an iron rod laid upon the surface would sink to the bottom by its own weight. It varies from ten to thirty-five feet in depth, and the bottom is composed of sand and clay. On the eastern border, for about a mile and a-half, the greatest difficulty in the construction of the road occurred. Here an embankment of about twenty feet above the natural level was formed, the weight of which resting on a soft base pressed down the original surface: many thousand cubic yards gradually and silently disappeared, before the desired level was attained: but, by degrees, the whole mass beneath, and on either side of this embankment, became consolidated by the superincumbent and lateral pressure, and the work was finally completed. Hurdles of brushwood and heath are placed under the wooden sleepers, which support the rails over the greater part of this moss; so that the road may be said to float on the surface.

So impracticable had it been deemed to carry the road over this bog, that even a civil-engineer denounced the project in his evidence before parliament; and afforded an instance of incautious pre-judgment, as the following amusing extract from the parliamentary proceedings will show:—

Question. Tell us whether, in your judgment, a rail-road can be safely made over Chat-Moss, without going to the bottom of the bog?

Answer. I say, *certainly not.*

Q. Will it be necessary, therefore, in making a permanent rail-road, to take out the whole of the moss to the bottom, along the whole line of road?

A. Undoubtedly.

Q. Will that make it necessary to cut down the thirty-three or thirty-four feet of which you have been speaking?

A. Yes.

Q. And afterwards to fill it up with other soil?

A. To such a height as the railway is to be carried; other soil mixed with a portion of the moss.

Q. But suppose they were to work upon this stuff, could they get their carriages to the place?

A. No carriage can stand on the moss short of the bottom.

Q. What would they do to make it stand,—laying planks or something of that sort?

A. Nothing would support it.

Q. So that if you could carry a rail-road over this fluid stuff,—if you could do it, it would still take a great number of men, and a great sum of money. Could it be done, in your opinion, for 6000*l.*?

A. I should say 200,000*l.* would not get through it.

Q. My learned friend wishes to know what it would cost to lay it with diamonds?

With this jeering query we may well conclude our extract from such evidence, given by such a witness, who must, indeed, have been surprised, if not mortified, at seeing, a few years afterwards, a fine line of rail-road thrown over the very bog which he declared to be impassable; to see carriages going over it *without going to the bottom;*—carriages laden with tons of merchandise: and, instead of common diamonds forming the pavement, to see "*black diamonds*" whirling over it, to feed the furnaces of thousands of factories, which this fine road benefits; and to reflect that the road, which this witness declared would cost more than *two hundred* thousand pounds, actually cost, from the first draining of the bog, to the subsequent completion of the line over its surface, no more than *thirty* thousand pounds.

In the spring of 1829, another set of labourers were taken on, in order to accelerate the completion of the whole line, by working night and day. The effect of this plan was soon apparent; and had it not been for the extremely wet summer and autumn of that year, the whole road would have been completed by the beginning of 1830. The long and heavy rains greatly impeded the work, and pumps were often in constant action, to clear the cuttings, which frequently assumed the appearance of a canal, instead of a railroad.

Let us now say a few words respecting the rails, and the mode of fixing them. So little experience had been obtained with regard to this novel mode of conveyance, that it was long a matter of doubt, whether the rails should be made of cast or of wrought iron. The former was cheaper, but the latter more durable. After much consideration, wrought iron rails were adopted, 3847 tons of which were required: and the cast iron pedestals, to which they were to be fastened, amounted to 1428 tons more. The rails were made in lengths of five feet each. The blocks, or sleepers, were sometimes of stone, at other times of wood; as circumstances required. Those of stone, extend about eighteen miles, and contain about four cubic feet each: those of wood, are laid chiefly across the embankments, where it was expected the road would subside to a small extent. The stone sleepers are let firmly into the permanent road, at intervals of three feet. In each block two holes are drilled, for the reception of oaken plugs. At every three feet the rails are supported on, and securely fastened to, cast iron chairs or pedestals, which latter are spiked down to the plugs. The rails are about two inches broad, and rise about an inch above the surface. There are *two* lines of road throughout; but, at Liverpool, under the warehouses, there are *four* lines, on account of the greater traffic at that particular spot.

On the 1st of May, 1830, the Rocket steam-engine, with a carriage full of company, passed over the road-way, along the whole extent of Chat-Moss, thus affording the first triumphant proof of the possibility of forming this much-contested road.

We stated in the last chapter, that the company, even up to the time of the completion of the line, had not decided upon the means of transporting the carriages, whether by horses, by stationary steam-engines, or by locomotive engines. Numerous schemes were proposed to the directors, recommending improved powers or improved carriages; and these schemes came from persons of all classes; from professors of philosophy, down to the humblest mechanic; all were zealous in proffering assistance. A writer in one of the periodicals of the time, thus amusingly sums up these schemes:—"Every element, and nearly every substance, were brought into requisition, and made subservient to the great work. The friction of the carriages would be reduced so low, that a silk thread would draw them; and the power to be applied was to be so vast, as to rend a cable asunder. Hydrogen gas and high-pressure steam,—columns of water, and columns of mercury,—a hundred atmospheres, and a perfect vacuum,—machines working in a circle, without fire or steam, generating power at one end of the process, and giving it out at the other,—carriages that conveyed every one its own railway,—wheels within wheels, to multiply speed, without diminishing power,—with every complication of balancing and countervailing forces, to the *ne plus ultra* of perpetual motion. Every scheme, which the restless ingenuity or prolific imagination of man could devise, was liberally offered to the company; the difficulty was to choose and to decide."

Previous to this time, the theatre of practical experience on railways, was the Stockton and Darlington line, spoken of in the last chapter; and the railways in the Newcastle collieries. All the modes, heretofore in use, of propelling carriages on railways; viz. by animal power, by fixed engines, and by locomotives, had been there exemplified. Facts, then, were wanting to lead to a correct decision; and the personal inspection of some of the company's engineers seemed necessary to produce a satisfactory result. Accordingly, the directors empowered four experienced engineers to visit the different railways, and observe the comparative values of *stationary* and *locomotive* engines, and then to report on the relative merits of the two methods. This was done; and the decision of the directors, guided by the reports of the engineers, was in favour of locomotives. Their next object was to stimulate the inventive genius of the country, to supply them with the best form of engine for the purpose. They, therefore offered, in the spring of 1829, a prize of five hundred pounds for the best locomotive engine, and appointed the following October, for a public trial of the claims of the competitors. The conditions of the prize were, that the engine should produce no smoke, that the pressure of the steam should be limited to fifty pounds on the square-inch; that the engine should draw at least three times its own weight, at the rate of not less than three miles an hour; that it should be supported on springs, and not exceed the height of fifteen feet.

In the following October three engines competed for the prize:—the Rocket, constructed by Mr. Stephenson; the Sanspareil, by Mr. Hackworth; and the Novelty, by Messrs. Braithwaite and Ericson. Of these engines, the ROCKET gained the prize. A line of railway was chosen for the trial, on a level piece of road, about two miles in length, near Rain-hill: the distance between the two stations was a mile and a-half; and the engine had to travel this distance backwards and forwards ten times, thus making the journey thirty miles. The Rocket performed this journey twice; the first time within two hours and a-quarter, and the second time within two hours and seven minutes. Its speed varied at different parts of the journey: its swiftest motion being rather above twenty-nine miles an hour; and its slowest pace about eleven miles and a-half an hour. This was the only engine which performed, in complete style, the proposed journey; the others having become disabled from accidents, which occurred during the contest.

We come now to the time, when the rail-road approached its completion. Little more than three years had been occupied in this work; in which more than ordinary difficulties had been met and overcome. The total cost, from the commencement, to the time when warehouses, machinery, and carriages were completed, and the railroad ready for active operations, is estimated at 820,000*l*.

Previous to the 15th of September, 1830, extensive arrangements had been made for the important ceremonial of opening the railway on that day. All the loose stones and rubbish, which obstructed the tunnels in different parts of the line, were removed; the rails were well swept; and strong fences were erected along the high ground, on each side of the deep cuttings, for several miles, to prevent the spectators from intrusion, and to protect them from danger in their eagerness to witness the procession. There were also many constables and soldiers to assist in keeping the railroad clear; and places were assigned to a large number of persons, who had previously been so fortunate as to procure tickets. Each engine, and its train of carriages, had distinguishing flags; and the number of these locomotives was eight: the Northumbrian, the Phœnix, the North Star, the ROCKET, the Dart, the Comet, the Arrow, and the Meteor. All these engines were built by Messrs. Stephenson, of Newcastle. It was expected that three patent engines, built by Messrs. Braithwaite and Ericson, would have been also in readiness; but not having arrived from London early enough to be subjected to a preliminary trial, the directors thought it would not be prudent to allow them to make part of a procession, which it was of the utmost consequence, should be exposed to as few risks of failure as possible. Messrs. Stephenson's engines had been repeatedly and successfully tried several weeks before.

The ceremony was honoured with the presence of the Duke of Wellington, Sir Robert Peel, and many other distinguished individuals. The Northumbrian was appointed to take the lead of the procession, drawing a splendid carriage appropriated to the Duke and Sir Robert, and about thirty other eminent men. Each of the other locomotives drew four carriages, containing between eighty and ninety persons; thus making the total number of individuals, accommodated with seats in the procession, to be about six hundred.

At twenty minutes to eleven o'clock, the procession commenced its progress towards Manchester, the Northumbrian taking exclusively one of the two lines of rail, and the rest of the engines the other. A periodical writer of the day, who was present, states that the brilliancy of the procession,—the novelty of the sight,—and considerations of the almost boundless advantages of the stupendous power about to be put in motion,—gave to the spectacle an unparalleled interest. On every side the tumultuous voice of praise was heard; and countless thousands waved their hats, to cheer on the sons of enterprise in this their crowning effort. The engines proceeded at a moderate speed toward Wavertree-lane; when, increased power having been added, they went forward with great swiftness, and thousands of people then fell back, whom all the previous efforts of a formidable police could not move from the road. Numerous booths and vehicles lined the various roads; and were densely crowded. After passing Wavertree-lane, the procession entered the deep ravine at Olive Mount, and the eye of the passenger could scarcely find time to rest on the multitudes that lined the roads, or admire the various bridges thrown across this great monument of human labour. Shortly afterwards, Rainhill-bridge was neared, and the inclined plane of Sutton began to be ascended, at a more slackened pace. The summit was soon gained, and twenty-four miles an hour became the máximum of the speed. About noon the procession passed over the Sankey-viaduct. The scene at this part was particularly striking. The fields below were occupied by thousands, who cheered the procession, in passing over this stupendous edifice: carriages filled the narrow lanes; and vessels, on the water, had been detained, in order that their crews might gaze up at the gorgeous pageant, passing far above their mast-heads. At Parkside, seventeen miles from Liverpool, the engines stopped to take in a supply of water and fuel; and many of the company having alighted in the interval, were walking about, congratulating each other on the truly delightful treat they were enjoying, all hearts bounding with joyous excitement, and every tongue eloquent in the praise of the gigantic work now completed, and the advantages and pleasures it afforded.

At this point of the proceedings occurred the sad accident which we are about to relate, and which threw a dark cloud over a day, devoted to honourable triumph and well-earned festivity.

The Phœnix and North Star, having taken in their supplies of water and fuel, had resumed their journey, and passed the Northumbrian, which remained stationary on the other line, in order that the whole train of carriages might here pass in review before the Duke of Wellington, and his party. Several gentlemen had embraced the opportunity of alighting from the state-carriage, and were walking about on the road; among which number was Mr. Huskisson, who caught the eye of the Duke of Wellington. A recognition immediately followed, when the Duke extended his hand, which Mr. Huskisson advanced to take. At this moment the Rocket came rapidly forward upon the other line, and a cry of danger was raised. Several gentlemen succeeded in regaining the state-carriage; but Mr. Huskisson, who was in a weak state of health, became flurried; and after making two attempts to cross the road upon which the Rocket was moving, ran back, in great agitation, to the side of the Duke's carriage. White, the engineer, saw the unfortunate gentleman, as the engine approached, in a position of imminent danger, and immediately endeavoured to arrest its progress, but without success. Mr. Holmes, M. P., who had not been able to get into the carriage, stood next to Mr. Huskisson, and perceiving that he had altogether lost his presence of mind, called upon him "to be firm!" The space between the two lines of rails is just four feet; but the state-car, being eight feet wide, extended two feet beyond the rail on which it moved, thus diminishing the space to two feet between its side and the rail on which the Rocket was moving. This engine, also, projected somewhat over the rail on which it ran; thus still further diminishing the standing room to not more than a foot and a-half, when the vehicles were side by side on the opposite rails. In addition to this, the door of the state-car happened to be wide open; so that it was impossible for the Rocket to pass without striking it. Mr. Huskisson had just grasped hold of this door, when he was warned of the approach of the Rocket. Mr. Littleton, M. P., had sprung into the state-car, and had just pulled in Prince Esterhazy, when he saw Mr. Huskisson alarmed and agitated, grasping the door with a trembling convulsive hold. At this moment the Rocket struck the door, and Mr. Huskisson was thrown to the ground across one of the rails of the line, on which the engine was advancing, the wheels of which went over his leg and thigh, and fractured them in so dreadful a manner, as to produce death before the lapse of many hours.

After this melancholy accident, the Duke of Wellington and Sir Robert Peel desired to terminate all festivity and return to Liverpool, instead of going on with the procession to Manchester. A magistrate, however, stated that, if the procession did not reach Manchester, where an unprecedented concourse of people was assembled to witness it, he should be fearful of the consequences to the peace of the town. The directors likewise stated that they were but trustees for property to an immense amount; that the value of that property might be affected if the procession did not go on, and thus demonstrate the practicability of locomotive travelling on an extensive scale; and that, though the illustrious Duke and his *cortège* might not deem it advisable, as a matter of delicacy, to proceed, yet it was the duty of themselves, the directors, to complete the ceremony of opening the road. This reasoning being just, the Duke consented to proceed, but expressed his wish to return as soon as possible, and refrain from all festivity at Manchester.

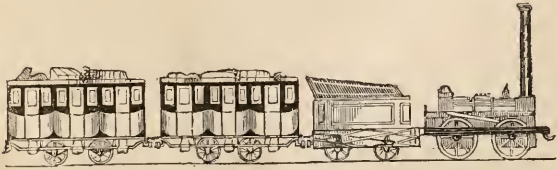
The procession accordingly resumed its onward progress, and arrived at Manchester at a quarter before three. The Duke and his party did not alight, but the greater portion of the company in the other carriages descended, and were shown into the large upper rooms of the Company's warehouses, where they partook of refreshments.

The Company returned in detached parties, after considerable delays on the road, to Liverpool. The melancholy accident, which deprived an estimable man of his life, and the country of a talented statesman, broke up the union of the party, and made the termination of the day as melancholy as its dawn had been propitious.

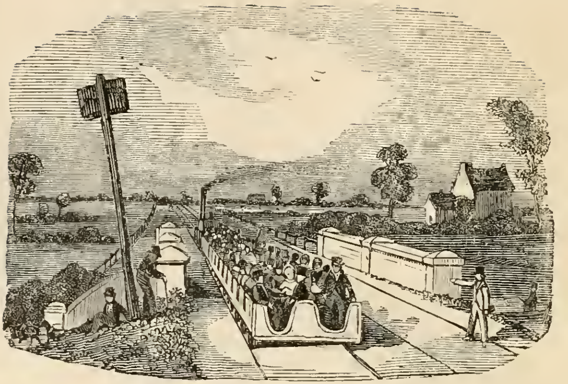
However, as far as the rail-road was concerned, the triumph was complete. On the following Thursday morning public traffic on the line commenced; the Northumbrian left Liverpool with 130 passengers, and arrived at Manchester in one hour and fifty minutes. In the evening it returned with 120 passengers, and three tons of luggage, in one hour and forty-eight minutes. This was the first journey performed for hire. The fare charged was 7*s.* for each passenger.

On Friday the 17th, six carriages commenced running regularly between the two towns.

Such, then, is a brief account of the rise, progress, and completion of probably one of the grandest efforts at social improvement, which has been witnessed in modern times. The business of the Liverpool and Manchester railroad has continued up to the present time in successful operation; its commercial value to the two towns and indirectly to the country at large, has long been admitted; its success, too, has been such as to remunerate the spirited individuals who contributed their means to the undertaking; and it has been undoubtedly the source of a spirit of emulation which has led to the construction of many other lines of rail-road which, in various parts of the country, are now completed or are advancing rapidly to completion.



The Rocket, with a train of Carriages attached.



Railway Scene.

CHAPTER XVIII.

The Rail-road system.—Province of the Legislature.—Formation of Railway Companies.—Economy of Railways.—Station-houses.—Supply of water and fuel, &c.—Locomotive Engine and its attendants.—Two Engines to one train.—Mile-stones.—Rapidity of transit.—Signals—day and night.—Police.—Improved Signals.—Telegraphs.—Steam-whistle.—Winds, effects of.—Anemometers.—Tunnels, salubrity of.—Variations in the construction of Railways.—Liverpool and Manchester,—London and Birmingham,—Great Western,—London and Brighton,—London and Greenwich Railways.—Railways in Ireland.—Conclusion.

In continuing the subject of rail-roads from the establishment of the line which connects the two great towns of Liverpool and Manchester, the natural course of our inquiry would lead us to trace the origin and progress, not only of the principal rail-roads of our own country, but those also of other lands; and to conclude our volume with a comparative view of rail-roads, their statistics, their political influence, and the probable effect they will have on social improvement: but the subject of rail-roads is a vast one, into which much speculation must necessarily enter, on account of its novelty; and setting aside the fact, that such an inquiry is above the purposes of the present volume, we would rather wait until the importance and influence of rail-roads have been more fully appreciated. We propose, therefore, to occupy the remainder of our space with a few details on the general management and economy of rail-roads—details which form constant subjects of conversation with rail-road travellers, among whom information is not always of the most accurate or precise description.

Many persons are at a loss to know why an Act of Parliament is necessary before a railway can be constructed; why the enormous sums of 70,000*l*, with respect to the London and Birmingham, and 80,000*l* with respect to the Great Western railways, should have been spent in obtaining the Acts of Parliament. We shall soon perceive a reason for this, when we consider the enormous powers with which the railway directors are invested; that proprietors of land are *compelled* to sell their property to the railway companies, so much of it as may be required. The proprietor may ask a large price for his land, and, generally speaking, the price paid is very liberal; but still this circumstance does not remove the somewhat startling fact, that the sale must take place, whether the proprietor desires it or not. Now so much respect do the laws of England pay to private property, that a special Act of Parliament is required before a company can thus have a command over the property of other persons. The proprietors of land have an opportunity of stating their opinions, either for or against a railway, which is proposed to pass through their estates; and the Houses of Parliament weigh well the proportion between those who do, and those who do not, object. The legislature is also bound to see that the natural resources of the country, such as rivers, mineral treasures, &c., are not unduly interfered with. Again, as the constitution of a railway has a strong tendency to drive other vehicles off the old turnpike-road, which it is intended to supersede, it is necessary to take such precautions as shall prevent the railway company from possessing the obnoxious tendency of a monopoly. There are many minor points which it is necessary to make binding on a railway company; and these can only be placed on a right footing by a special Act of Parliament.

But this being granted, it cannot but be lamented that the cost of obtaining an act is so enormous. It is not our business to point out what reforms would produce economy in this respect; we will only allude to the unfavourable light in which the legislature is placed, by a system which requires such a vast dead loss to the shareholders of a company; for it must be remembered that the purchase-money for the land is altogether distinct from, and in addition to, the parliamentary expenses. Another evil arises from the same source:—when a company have obtained an Act of Parliament, they seem disposed to adopt a higher scale of charges to the public, as a kind of retaliation for the annoyance and expense incurred before the railway can be commenced. It has been stated, that in the year 1836, the passengers on the Liverpool and Manchester railway were 522,991; and that those on the Brussels and Antwerp railway amounted, in the same year, to 872,893. Now, in order to obtain data for a comparison of these numbers, we must take the population of the principal towns on the line:—it is found that the population of Liverpool, Manchester, and Warrington, amounts to 486,812; and that of Brussels, Antwerp, and Mechlin, to 209,200. If, then, we compare in each case, the number of passengers with the number of inhabitants, and bring them to the same ratio, there will be 2,025,100 passengers on the Liverpool and Manchester railway, instead of 522,910. A very large portion of this difference has been attributed, by a recent writer, to the far higher rate of charge on the English than on the Belgian railway.

The mode of obtaining an Act of Parliament for a railway, is sufficiently evident to those who pay the slightest attention to the proceedings of the Houses of Parliament, and need not be detailed here. A railway company consists of a number of shareholders, who embark their capital into one common stock; and the inducement to do so is very simple and palpable:—those who have spare capital, put it out to interest, in some way or other, and are always on the look-out for a mode of investment which will yield more than the government interest of about $3\frac{1}{2}$ per cent: if, therefore, there be reason to believe that the receipts on a railway will, after defraying all expenses, yield more than the above per centage of profit, nothing further is required to induce capitalists to embark in such a speculation: when, therefore, we look at the "prices of railway shares" in the daily journals, they will always afford us indications of the state of hope or of fear in which the shareholders are at that time, respecting the ultimate profit of the various undertakings. The high price which a capitalist is willing to give for a share in the Stockton and Darlington, the Liverpool and Manchester, the London and Birmingham, and a few other railways, shows the opinion which he entertains of the high rate of profit to be derived from them:—while, in many other instances, which we do not wish to name, the slender hope of profit renders the sum offered for a share very small. This is the key which opens to us the motives of monied men, and which enables us to understand the astounding fact that *ten millions* sterling will be spent on two only out of the large number of railways: *i. e.*:—the London and Birmingham, and the Great Western.

A company, then, being formed, and funds supplied, the future operations,—and indeed, all those from the very commencement,—are placed in the hands of a managing committee or directory;—a principle of government which we find to prevail in every age, in every country, and in every grade of life. The management of a company is, for many reasons, not placed in the hands of one individual; the principle that "two heads are better than one," is felt and acted on. A board of directors is generally appointed, who superintend the whole management of the undertaking, and present periodical reports to the shareholders at general half-yearly meetings. These directors are chosen by the shareholders, and act, in some cases with, and in others without, salary.

But we have abundant evidence in common life, that to determine that a thing shall be done, and to see that it *is* done, are two different things, and often require different powers of mind. This is felt in the management of a railway, in which, although the directors, if well chosen, are able to lay down excellent rules, they are too many in number, and perhaps not well fitted by talent, to see those rules strictly acted on: they, therefore, usually appoint an experienced, responsible executive officer, who has nothing to do with making laws and rules; but who sees that those which are made are put in execution:—to do this, the stations, the engines, the police, the warehouses, must all be under his supervision, and the respective managers of them must act under his orders. If the reader were to devote five minutes' thought to this subject, he would see how strongly the principle of a constitutional government is acted on in these matters; there is an elective body, a legislative body, an executive, or ministry, and an extensive train of paid servants, who receive their salaries out of the funds of the elective body; and in the commercial as well as in the political body, the principle of ultimate responsibility to the elective body is strongly marked, although its operation may not always be visible at the surface.

This, then, is the corporate machinery by which the shareholders of a company proceed to attain their object; and in all the details which we have hitherto given respecting railways, the reader will understand that the directors of a company, having received general instructions on the more important points at the half-yearly general meeting, act on their own responsibility in everything else,—select the persons who shall construct the rail-way,—consult with and direct the engineer in his progress,—call for money from the shareholders, when required,—disburse it when and where they may deem it to be most necessary,—and invest the unemployed portion in bankers' hands;—being accountable for all this to the shareholders, at the next half-yearly meeting.

Let us suppose, then, that under the orders of such a board of directors, a railway has been constructed,—locomotive engines, adapted to the width, or *gauge* of the rails, built,—strong vehicles for the conveyance of luggage and merchandise, and lighter ones for passengers, more or less commodious according to the fare charged, constructed and fitted to the railway,—and all prepared for running the vehicles on the rails. It will be obvious that much will be required before business can commence,—not only a disciplined corps of men, but other arrangements which merit our notice.

In the first place we may mention *stations*, and the object for which they are required. We must remember that the two great towns at the ends of a line are not the only ones which are to derive benefit from the railway. The line, in most cases, passes between several large towns, some of which are a few miles to the left and others to the right of it. Now, such is the advantage of quick transit, that even if a town were twenty miles from the nearest point of a railway, it might be desirable to travel those twenty miles in a stage-coach, and then proceed *viâ* railway, in preference to performing the journey by the old coach road, which is, in such case, very likely to be the shorter distance of the two. Now, no person can go on a railway at an intermediate point in its length, with that facility which a passing traveller can mount a stage-coach,—and this for several reasons:—if a steam-carriage stopped every few minutes, in order to take up a passenger, a most serious loss of locomotive power would result, not only from loss of steam, but also from loss of momentum:—if a casual passenger could mount at any part of the line, it is manifest that the railway would not be sufficiently railed off and guarded, for the prevention of accidents:—lastly, if a passenger entered and left the train at any points indiscriminately, the passage-money must be paid to the engine-man, or to some person accompanying the train, a mode, the inconvenience of which requires no comment. The same remarks apply, and even in a still greater degree, to the carriage of heavy merchandise.

For these reasons, therefore, stations are erected at various distances along the line of road, at each of which regular officers attend, having well-defined duties to perform. These stations are arranged with reference, as much as possible, to the convenience of populous towns lying on the right or left of the railway. It is believed, that if these stations were very numerous, not only would the existing rate of traffic from neighbouring towns greatly increase, but traffic would even spring up from places which were, from their seclusion, deprived of traffic with other towns. The limit to the number of stations is found when the expense of maintaining them equals the profit derived from them.

But the advantages of a station at which a train can stop to take up passengers and goods are not confined to those we have just mentioned. The consumption of fuel and water by the locomotive engines is very great; and it is necessary to have depôts where a supply of these necessaries,—this provender for steam-horses,—can be taken in. The passenger-station may therefore consistently act as these depôts, especially as the supplying of water and fuel to the engine, and the admission of passengers and goods to the carriages, may be carried on at the same moment, and thus time may be economized.

The stations actually in use in our various railways are of different characters. In some instances, the station is merely a room, which serves both for office and waiting-room, from which the passengers and parcels from a small town or village can be taken upon the railway, when one of the trains pass. But generally speaking, the stations are of greater extent: they contain an office for transacting the business of the stations, and one or more waiting-rooms. A useful suggestion has lately been made in an article in the *Encyclopædia Britannica;* viz., that there should be a separate waiting-room for ladies, with a respectable female to attend them, and to provide them with refreshments at a moderate price. Such stations also generally contain rooms for the inspector of police, and for clerks and porters; and also an office for merchandise. Where the station is an important one, there is often an engine-house,—a steam-engine to pump water,—an engineer's room,—a supply of spare carriages, &c., kept in a place properly secured and protected from the weather.

The arrangement of these stations is generally, and ought always to be, if practicable, such that passengers can step from a platform into the carriages without either ascending or descending; and during the stoppage of the train, the whole of the passengers, while entering or leaving the carriages, should be protected over head by a roof thrown across the railway. If the station be well ordered, a great deal may be done in a very few minutes. The time at which the train begins its journey, together with the general rate of travelling, being known, the time of the arrival at the station can be pretty accurately predicted, and everything should be in readiness just before the train arrives. In the first place, if the station be a depôt for fuel and water, the engineer is prepared to supply the tender of the engine with those materials the moment it arrives:—if any slight repairs are required, tools, &c. should be at hand.—horses and private vehicles should be drawn up in readiness to be placed on the trucks or skeleton carriages:—heavy goods should be so warehoused as to be hoisted into the train wagons with expedition;—and the passengers should be at hand to take their places in the carriages. On the other hand, there are likely to be passengers, merchandise, horses, carriages, &c., which quit the railway at that station; in such a case it has been recommended that all which leaves the train should be landed on the opposite side of the railway from that at which passengers, &c. are taken in, by which means much confusion and loss of time will be avoided. It is recommended that the water-tank and crane, and the coke store, for supplying the engine, should be somewhat in advance of the passengers' waiting-room, while the conveniences for attaching or detaching horses, private carriages, &c., should be in arrear of it: by these means, all the various duties which we have mentioned may be attended to simultaneously. Two clerks, an inspector, four policemen, and a few porters, are the principal persons required at such a station.

Such, then, are the purposes for which stations are necessary, and such is a brief outline of the proceedings which occur when a train stops at a station.

We are so much in the habit of regarding locomotive engines as self-moving machines, that we are apt to forget that, like a clever but impetuous child, such an engine requires more vigilant watching in proportion as it becomes more powerful. If, on the one hand, we feel the advantages, in a commercial point of view, derived from a rate of transit equal to thirty miles an hour, we must, on the other hand, admit that any accident, resulting from carelessness and inattention, is likely to be much more disastrous:—for instance, on one of the embankments of the Liverpool and Manchester railway, a locomotive engine on one occasion got off the rails, and was stopped only just in time to prevent it from being precipitated down the embankment, and perhaps dragging the carriages after it; and the more rapidly the engine might have been going at that moment, the more ruinous would have been the effects which followed.

For these reasons a large share of responsibility rests with the *engine-man*, not only in taking care of the management of the engine, considered as such, but in directing its progress along the road, in its capacity of a travelling vehicle. Before a train of carriages starts on a journey, the engine-man examines the engine carefully, to see that every part of it is in working order and fit for immediate use. He also sees that the tender has its proper complement of coke and water, and that the oil for lubricating the joints of the engine is properly supplied. It is frequently arranged, that the engine shall be driven to and fro for a short distance on the rails previous to being attached to the train, in order to see that everything is in readiness.

When the "steam is up," and the engine ready for starting, (during which time the carriages are taking their load of passengers and merchandise,) it is brought down, or backwards, to the head of the train, and hooked to the foremost carriage. The steam is then applied to the propulsion of the engine, and with it, of all the carriages which follow it. The engine-man has now to keep a vigilant look-out, to keep the engine in its right course, and to watch the various valves, &c. on which his power over the engine depends. He has a gauge, already described, by which he can tell how much water is in the boiler, and from time to time he pumps an additional supply into it from the tank in the tender. He has to see that the furnace is properly supplied with coke, and to regulate the quantity added according to the power of the steam at the moment.

Whatever may be the rate of travelling, it is considered desirable to lessen that rate while passing another train which is standing still, as the stoppage may indicate that all is not right. The rapidity of progress, when approaching towards a station, must also be slackened with much judgment, in order to bring the train to a stop at the proper place. Besides this, the engine-man has a means of communicating with the guard at the back of the train, so that he is prepared to stop the engine whenever the guard conveys a signal to him so to do.

The journey completed, the engine-man has not fulfilled all his duties until the engine is laid up in its place: he sees the fire raked out, and any remaining steam blown off. Even when the water in the boiler has become quite cold, the engine is not yet reduced to a quiescent state; for, instances are stated to have occurred in which the "man-hole" of the engine has been opened when the water has become cold, and a man has entered; and upon introducing a lighted candle, an explosion has taken place, and the man has been killed: this shows that we do not yet understand all the phenomena connected with the generation of steam in a close boiler.

The engine-man, on giving up the charge of his engine, makes a report of anything which may have occurred on the road, such as the breaking or displacing of rails, injury happening to engines, carriages, &c., and any other circumstances which, from his situation in the train, he may be supposed to be the best qualified to speak upon.

We may here mention, that when a train is too heavy to be drawn with sufficient rapidity by one engine, two are employed. This has given rise to a difference of opinion, as to whether it would, in such case, be more desirable to have two half-trains, each with an engine, than one long one with two engines. It has been asserted, that no two engines work with precisely the same effective power; so that it is likely to happen that one of the two engines attached to a train would tend to move faster than the other, by which the latter would be *dragged* along, in some degree. It is, on the other hand, stated that the two engines soon equalize their rates of motion, perhaps on a somewhat similar principle to the known fact that two clock pendulums hanging on the same wall will soon oscillate isochronously, or in equal times.

The rate of travelling along the railway may be known by mile-stones set up at the sides, and which may be seen from the carriages; by the aid of these, and of a common watch, the rate of travelling may be easily noted. The author of the treatise before referred to, after alluding to the indistinctness of the mile-posts commonly used, recommends the employment of posts made of iron, with a box at the top. This box is triangular, with two of its faces presented obliquely to the road. Inside this box is a small lamp; and the faces of the box are opaque, with the exception of the openings which constitute the figures or letters. These figures would sufficiently show themselves during the day, and at night, the policemen could light the lamps, and thus make the figures visible then likewise.

A convenient mode has also been pointed out by the same writer, by means of which the engine may be made to tell its own rate of progress, provided we have a good seconds' watch at hand. There are four puffs from the blast pipe at every revolution of the driving wheels, so that at every fourth puff the wheels have made one revolution. A little common arithmetic would enable a person to construct a table of velocities, according to the diameter of the wheels, arising from the well-known ratio of 1 to 3.1416 between the diameter and the circumference. The following table would serve where the wheels are five feet in diameter:

Number of fourth puffs in 10 seconds.	Velocity in miles per hour.	Number of fourth puffs in 10 seconds.	Velocity in miles per hour.
15	16.06	23	24.63
16	17.14	24	25.70
17	18.21	25	26.77
18	19.28	26	27.85
19	20.35	27	28.92
20	21.42	28	29.99
21	22.49	29	31.06
22	23,56	30	32.13

It is very essential that a system of well-understood signals be adopted on railways; for if any accident happen a short time before the arrival of a train, it is of the first importance that the engine-man should have notice of it at a considerable distance from the spot where it has occurred. For instance, a rail may be displaced by the passing of the last preceding train, or the train itself may have been prevented from continuing its journey, either from some accident having happened to the engine, or from some other cause. Important as it is to have timely notice of any such accident by day, it becomes doubly necessary by night, when it is so much less in our power to know, by the assistance of the eye alone, what is doing, or what has been done, at some distance in front of us. We need hardly dwell on the dreadful nature of an accident occurring at night through any unforeseen obstacle to the progress of a train.

For these reasons there have been devised many arrangements which act as alarms, signals, telegraphs, &c. In the first place, there is a police force employed along the line of railway, whose duty it is to keep a watch at everything occurring, or likely to occur, along the line; to prevent intruders from climbing over the palisades, and entering upon the railway; to see that no stones are thrown, or suffered to fall, on the rails, by which the trains would be placed in imminent danger; to render assistance to passing trains in case of any accident happening; to assist in working a system of signals; and to perform many other duties of a similar nature. The policemen for each railway have a regular uniform, and are under a systematic code of regulations.

One of the duties of the policemen, as we have just observed, is to assist in making signals to approaching trains. On some of the railways it has been customary, when a train is approaching a spot where a policeman stands, for him to place himself in a conspicuous situation, with one or both arms extended, in a certain or understood manner; one position of the arms is to signify "all right," and that the train may proceed without fear of interruption; while another position implies that, for some reason or other, matters are going wrong, and that the train must stop when it approaches the policemen. In other instances the policemen are provided with little flags of different colours; and, on the approach of a train, he holds up one or other of the flags, according to the intimation which he wishes to convey; for instance, a red flag to intimate danger, and a green one as a signal that all is right.

But such modes as these can obviously only serve during the continuance of daylight, and can no longer be available when night comes on. As a night-signal, the following plan is sometimes adopted:—lamps are employed, which are capable, either of being fronted with stained glass, or by some other contrivance, of shedding coloured light along the line of the railway, and by causing the light thus shed to be red under some circumstances, and green or blue under others, a system of signals is at once obtained, available for night-time.

It has been suggested that all railways should make a red light at night, and a red flag by day, the symbols of danger. A green light should be placed at each station at the spot where the engine-man should slacken his speed, and a red light at the point where he is to stop. The police should have hand-lanterns, with a white glass and a red one, which latter can be turned round in an instant, whenever anything obstructs the passage of the railway; and the light held up at any train approaching, on seeing which the train is immediately to stop. A green glass may also be added, the signification of which would be, "proceed with caution;" the train should then come slowly on, and ascertain the reason for the signal.

There are other circumstances in which it is requisite to have signals. It is sometimes necessary for a train, or for the engine belonging to it, to pass from one line of rails to the other, by means of a diagonal sliding-rail. A little consideration will show that this sliding rail must be capable of moving within certain limits, so as to present itself in a certain position when an engine is proceeding from one line of rails to the other, and in another position when the engine maintains its straight course. Now it has been contrived that the sliding rail shall carry a vertical rod and a square sign-board, on which a lamp may be placed; and that the motion of the rail shall also give motion to the rod. If, then, the lamp be made to shed a red light on one side, and a green one on the other, the red light would be visible along the line when the sliding rail is in one position, and the green light when it is in another; and, by a previous arrangement of signals, an approaching train could tell, by the colour of the light presented, whether the sliding rail were in the proper position to enable the engine to pass straight onward, or to go on to the other rail, as the case may be.

Another kind of signal is one that shall act as an alarum, by which the officers at the various stations may know that a train is approaching. A man is stationed at a spot from whence he can see the approach of a train; and when the train has arrived to within two minutes' distance from him, he sets an alarum in motion, by which the people in the station-house may know that the train is at hand. A form of alarum employed is the following:—On pulling a sort of trigger, a weight, which had been previously wound up, begins to descend. By descending it turns a wheel, which in its turn works a pinion, and by some intermediate mechanism a clapper is set in motion, and is made to strike against a gong-shaped bell. The ringing of this bell, therefore, continues until the weight has descended, and thus acts as a signal to those in the station-house.

It has been suggested to institute a kind of telegraph-system upon railways, which would not only be advantageous for the operations of the company, but might also be made the means of communicating messages, &c., for private individuals, at so much per word, or on any other agreed terms. It is proposed to construct a telegraph at each station, and adopt such a system of telegraphic language as shall be visible at the next adjoining station. It has been calculated that a communication consisting of one single signal might be conveyed 100 miles in a minute and a quarter; and a message of some length, requiring several distinct signals, might be conveyed the same distance in half an hour. The utility of this to private persons, in a commercial point of view, is obvious at once; and the service rendered to the Company may be equally important. The suggester of the plan makes the following suppositive case:—"For instance, an accident happens to an engine ten miles from an engine station. The telegraph would send out another engine in a minute, with any commonly good look-out; whereas to send on foot would require two hours; thus deranging the time of all the succeeding trains. As another instance: a train starting from one end to the other of the line, perhaps leaves fifty passengers at some intermediate town; the telegraph might immediately make this known to the clerk of that station, who, if he had few passengers ready for the train, could prepare goods' wagons to put on, so that the engine should not go with half a load,—a matter of great importance, for the power absorbed by an engine before it can put itself in motion being one-third of its whole power, it follows that the relative expenditure of power per ton, is nearly six times greater with a load of ten tons than it would be with a load of one hundred tons."

Medical assistance, in case of accidents to passengers, might be procured in a very much shorter time if a telegraphic system of communication were employed, than if an advice-carriage were sent, even at its highest speed. If this system were put into operation, it would of course involve increased expense in several ways; but if it were afterwards made available for the conveyance of private messages, in the way above stated, it seems extremely probable that the cost of the telegraph would be repaid.

There is also an ingenious kind of alarum or signal adopted, under the name of the "Steam Whistle," by which the ear is brought into requisition, as a means of obtaining warnings in case of danger. The instrument is a whistle sounded by the gushing of the steam from the boiler through a simple piece of mechanism, and can be cut off or put in action as need may require. These whistles are sometimes heard at a distance of several miles, on a calm day. It has been suggested that it would be desirable to have two of these whistles with totally distinct sounds, one to be used on the arrival line, and the other on the departure line of rails; each would then serve as an alarum, and would also serve as a fog and night signal, which would at all times and in the densest fog give perfect notice whenever two engines approached each other, on which line they were respectively travelling, and thus go far to prevent the probability of a collision.

The last contrivance which we shall mention, that can consistently come under the subject of signals, is a mode of estimating the probable effects of a high wind, or the rate of progress of a train. That a high wind directly in the teeth of the travellers would retard the velocity, is evident from the slightest consideration of the effect of a similar power on the sails of a windmill or of a ship. But this is not all: it is found that a strong side-wind presses the flanges (or overhanging ledges) of the wheels against the rails, and gives rise thereby to a very considerable amount of friction. From these circumstances it follows that a certain force of locomotive power in the engine, which should enable it to draw a train at the required velocity under ordinary circumstances, would be unequal to the task when a high contrary or lateral wind is blowing; and it would be desirable at such a time to obtain the assistance of a second engine.

Now not only ought the engine-man to be aware of the changes which the wind is calculated to make in the rate of the engine's progress, but the engineer, or some other officer at the engine station, should likewise have the means of correctly estimating its power, so as to provide a second engine when necessary. The reader is probably aware that instruments called *anemometers*, (from two Greek words signifying *wind measurers*,) are sometimes employed to give indications of the force of the wind at any particular period. We will not here enter into a description of the various instruments which have been employed in scientific institutions, and other places, for this purpose, but we will describe a mode which has been suggested by the writer to whom we lately alluded, by which both the *direction* and the *force* of the wind could be observed by a person in one of the rooms of the station:—"If a vane with a long tail, high above the top of the engine-house, and having at its pointing end a board one foot square, be fitted up in the following manner, it will be sufficient for all the wants of the locomotive department. The vane should be fixed in a hollow pole, which should turn with it, and descend through a tube down to (within) about five feet of the floor of the engine-house, where there should be a horizontal dial-plate, on which should traverse a pointer fixed to the vane-pole. This pointer would always indicate the direction of the wind; and in order to ascertain its force, the board, one foot square, on the pointing end of the vane, should act on a spiral spring and work a drum by a wheel and pinion, communicating by a cord with a similar drum at the bottom of the vane-pole, where a vertical dial-plate should be fixed on the outside, and opposite to the lower drum, on which a hand traversing round the vertical dial-plate would show the force of the wind. According to the power of the engine, and the nature of the usual traffic, experience will soon point out when a second engine ought to be despatched; and a table being formed for each point of the compass for this, should then be invariably acted on at all times, unless other local circumstances occasioned any alterations in the general average of the loads."

Our readers may remember the warm discussions carried on both in and out of parliament, a few years ago, on the subject of *tunnels*, and the healthy or unhealthy state of the air in them. When an elevated tract of country has to be traversed by a railway, one of two plans must be adopted, *viz.*, there must be a deep excavation from the surface of the ground to the level of the railway, or there must be a tunnel cut through the elevated ground. The former plan is always adopted when the elevation is not too great; but beyond a certain limit, varying according to circumstances, it is no longer available, and the plan then adopted is to cut a tunnel.

The tunnel itself is not the only object of labour in such case; for there are shafts, or vertical openings, cut from the surface of the ground to the railway. The object of these shafts is two-fold; 1st. To afford convenient openings for the excavators while forming the tunnel. 2nd. For the purpose of ventilation, when the tunnel is finished. But notwithstanding these ventilating shafts, strong opinions were expressed as to the insalubrity of the air in such long underground tunnels. In order to set this matter at rest, five gentlemen inspected the Primrose Hill tunnel (London and Birmingham Railway), in order to ascertain the truth on this point. The gentlemen were, two physiceans, Drs. Paris and Watson; two surgeons, Messrs. Lucas and Lawrence; and a professor of chemistry, Mr. Phillips. Their report, which may, perhaps, be considered as too unreservedly favourable, is as follows:—

"We, the undersigned, visited together, on the 20th February, 1837, the tunnel now in progress under Primrose Hill, with the view of ascertaining the probable effect of such tunnels upon the health and feelings of those who may traverse them. The tunnel is carried through clay, and is laid with brickwork. Its dimensions, as described to us, are as follows: height, 22 feet; length 3750 feet; width 22 feet. It is ventilated by five shafts, from six to eight feet in diameter, their depth being 35 to 55 feet.

"The experiment was made under unfavourable circumstances; the western extremity being only partially open, the ventilation is less perfect than it will be when the work is completed; the steam of the locomotive engine was also suffered to escape for twenty minutes, while the carriages were stationary near the end of the tunnel. Even during our stay near the unfinished end of the tunnel, where the engine remained stationary, although the cloud formed by the steam was visible near the roof, the air for many feet above our heads remained clear, and apparently unaffected by steam or effluvia of any kind; neither was there any damp or cold perceptible.

"We found the atmosphere of the tunnel dry, and of agreeable temperature, and free from smell; the lamps of the carriages were lighted, and in our transit inwards and back again to the mouth of the tunnel, the sensation experienced was precisely that of travelling in a coach by night between the walls of a narrow street; the noise did not prevent easy conversation, nor appear to be much greater in the tunnel than in the open air.

"Judging from this experiment, and knowing the ease and certainty with which thorough ventilation may be effected, we are decidedly of opinion that the dangers incurred in passing through well-constructed tunnels are no greater than those incurred in ordinary travelling upon an open railway, or upon a turnpike-road, and that the apprehensions which have been expressed, that such tunnels are likely to prove detrimental to the health, or inconvenient to the feelings of those who may go through them, are perfectly futile and groundless."

Were we to proceed with the subject of railways into the minutiæ of working details, the limits of this small volume would be wholly inadequate. As we intend it for the general reader, and not for the man of science, we have throughout presented only the leading features connected with "roads and rail-roads," in order to show the links by which a successive chain of improvement has been carried on—by which a wagon pace of three miles an hour has become a wagon pace of thirty miles an hour—by which a journey of several days has become one of the same number of hours—and by which distances bid fair to be measured, in familiar conversation, by *hours* instead of by *miles*.

Great as has been the progress in railway construction within the last ten years, we are still only in the infancy of the subject. The form and weight of the rails—the chairs in which they are fixed—the mode of fixing—the supports, whether stone blocks or continuous timber bearings, on which the chairs are placed—the "gauge," or width of the rails, by which the width of the carriages must also be regulated—the best manner of passing a hill, whether by gradients, or cuttings, or tunnels, and the proportion in which all three may be combined—the degree of curvature in the direction of the railway which will cause a serious amount of friction—the ratio in which the air retards the velocity of a train in motion—and numerous other important elements of the railway system, are still the subject of serious and earnest inquiry among the eminent engineers whose powers have been called into requisition within the last fifteen years.

The reader will understand that, in giving a tolerably full account of the Liverpool and Manchester Railway, we intended it as a general type of all the great works which have succeeded it. This is the only way in which we could attain the object we had in view, since to describe in a similar manner the various parts of all the other railways, would have been utterly inconsistent with our brief space, and would, at the same time, have involved the repetition of the same *kind* of details, varied slightly according to circumstances. The construction of the Liverpool and Manchester railway comprised instances of almost every kind of engineering difficulties which have been presented by the other railways; it has served as a model for subsequent construction, and will ever remain a splendid example of the triumph of perseverance and science over natural obstacles.

A mere list of the other railways, now constructing, or lately constructed, would occupy a considerable space, and would be of but little interest to the general reader. The most noble one yet opened is the London and Birmingham, which, from the difficulties to be encountered, and the masterly way in which everything has been conducted, has cost 49,000*l.* per mile, and by the time everything is completed, will have absorbed a capital of five millions and a-half sterling—a circumstance to which there is no parallel in private enterprises of a similar kind.

The Great Western railway, which will probably cost five millions, and which will extend from London to Bristol, is distinguished by two deviations from the usual course pursued in these matters—viz., that the rails and chairs are laid on continuous timber bearings, instead of on isolated stone blocks; and that the width of the rails, instead of being four feet eight inches, as in most other railways, amounts to the large distance of seven feet. So much difference of opinion, and, indeed, we may say, so much ill feeling, has been manifested on the question of the necessity for these changes from the ordinary course pursued, that we are unwilling to enter into any details on the subject, especially as it is at present a speculative question which cannot be set at rest by anything short of practical disinterested inquiry.

The London and Brighton line has been distinguished, unfortunately distinguished, from all others, by the ruinous expense incurred without the slightest progress having been made in the actual construction of the railway. The source of this is obvious enough—four or five competing companies besieged the legislature all at once for acts of parliament; and as not more than one act can be granted, it is plain that most, if not all, the competitors must be worsted. As it will be several years before a railway will exist between London and Brighton, we will not enter into details respecting the parliamentary decision on the subject of that line.

The London and Greenwich railway is remarkable as being one of the finest specimens of brick-work in England. It is wholly constructed on brick arches, running through the heart of Southwark, and through a tolerably open country towards Deptford, and from thence onward to Greenwich. This railway must be classed among those which have not hitherto yielded an adequate rate of profit.

The subject of railways in Ireland has occupied a large share of attention, principally with reference to the question how far Government would be justified in taking into its own hands the arrangement and construction of Irish railways. Nothing of that kind has occurred in England, because where capital exists abundantly among the commercial and manufacturing classes, the less Government interferes with mercantile transactions the better; but in Ireland the same circumstances do not present themselves. This country, for reasons which we need not here discuss, is in an unfortunate condition, and its natural resources being not yet brought into requisition, the question of Government interference assumes a different character. Some able reports have been prepared by commissioners, but as no legislation has yet taken place on the subject, we need not consider it at greater length.

In concluding the subject of Roads and Rail-roads, the reader may probably expect to find a comparative view of the dangers attending the two modes of locomotion. A few observations will, we think, be sufficient to remove the common prejudice, that steam is a more uncontrollable, and consequently less safe, prime-mover than animal power. This subject has been considered* under four distinct heads; *viz.*, 1. The dangers of the road. 2. The dangers of the carriage. 3. The dangers of the locomotive power. 4. The dangers arising from momentum, or from the weight of the burden, multiplied by the velocity at which it is conveyed.

1. It certainly appears that a rail-way must be less dangerous than a high-road: because it is flat instead of hilly; because a surface of iron is smoother than a surface of broken stones; because the lip of the rail which confines the wheels is an extra security not obtained on the common road; and because wagons, vans, carts, private carriages, and all other vehicles, as well as horses and cattle belonging to the public, are rigorously excluded.

2. A railway car is less dangerous than a stage or mail-coach, because its centre of gravity, when empty, is low instead of high; because its passengers sit low instead of high; inside and not outside; because its axles, receiving no jerks, are less liable to break; and consequently because, altogether, it is less liable to overset.

3. A locomotive engine must be less dangerous than four horses, because it is not liable to run away, tumble down, or shy at strange objects or noises; because it has no *vice* in it; because it is not, like a horse, retained and guided by numberless straps and buckles, the breaking of any one of which would make it take fright; and, lastly, because by the opening of a valve, its restless, enterprising spirit can at any moment be turned adrift, leaving nothing behind it but a dull, harmless, empty copper vessel.

4. If a railway train at full speed were to run against the solid brickwork of a tunnel, or to go over one of the steep embankments, the effect would, mechanically, be

* See *Quarterly Review*, vol. LXIII., p. 14.

infinitely greater, but perhaps not more fatal, to the passengers than if the mail at its common pace were to do the same. Besides, a coach is exposed to numberless chances of accident, from which the railway train is altogether free. We learn, too, from the official reports of ten railways, that out of more than forty four millions of travellers not more than about ten have been killed; whereas the records of stage-coach travelling are, as the reader knows, abundantly supplied with accidents of the most disastrous kind.

The effect of roads, bridges, and canals, &c., upon civilization can be estimated with sufficient accuracy, because, in treating of them, we are fortified by centuries of past experience: but it is not so with rail-roads; they are yet infants,—gigantic infants it is true,—and we can scarcely tell what tremendous consequences may not result from their vigorous growth. "Supposing," says an accomplished writer, "that rail-roads, even at our present simmering rate of travelling, were to be suddenly established all over England, the whole population of the country would, speaking metaphorically, at once advance *en masse*, and place their chairs nearer to the fireside of their metropolis by two-thirds of the time which now separates them from it; they would also sit nearer to one another by two-thirds of the time which now respectively alienates them. If the rate were to be again sufficiently accelerated, this process would be repeated; our harbours, our dock-yards, our towns, the whole of our rural population, would again not only draw nearer to each other by two-thirds, but all would proportionally approach the national hearth. As distances were thus annihilated, the surface of our country would, as it were, shrivel in size until it became not much bigger than one immense city, and yet by a sort of miracle every man's field would be found not only *where* it always was, but *as large* as ever it was."

LONDON: JOHN W. PARKER, ST. MARTIN'S LANE.

* A FAMILIAR HISTORY of BIRDS; their Nature, Habits, and Instincts. By EDWARD STANLEY, D.D., Lord Bishop of Norwich, Pres. Lin. Soc. *New Edition.* Two Vols. With many Engravings, 7*s.*

* DOMESTICATED ANIMALS considered with reference to Civilization and the Arts. By MARY ROBERTS. Also,

* WILD ANIMALS; their Nature, Habits, and Instincts, and the Regions they inhabit. Both with Engravings. 3*s.* 6*d.* each.

* MINERALS and METALS; their Natural History and Uses in the Arts; with Accounts of Mines and Mining. 2*s.* 6*d.*

THE HOUSE I LIVE IN; or, Popular Illustrations of the Structure and Functions of the Human Body. With Cuts, 2*s.* 6*d.*

"I am fearfully and wonderfully made!"

CONVERSATIONS ON GARDENING AND NATURAL HISTORY. With Engravings, 2*s.* 6*d.*

* THE BOOK of TREES; describing the Nature and Products of the principal Timber Trees, and the larger species of Palms. With numerous Engravings. 2*s.*

* BOOK of ANIMALS. BOOK of BIRDS. BOOK of FISHES. BOOK of REPTILES. BOOK of SHELLS. 1*s.* 6*d.* each. All with numerous Engravings.

---

* THREE WEEKS IN PALESTINE AND LEBANON. With many Engravings. 3*s.*

TWO YEARS AT SEA: being the Narrative of a Voyage to the Swan River and Van Diemen's Land; thence, to the Burman Empire, and various parts of India. By JANE ROBERTS. With Engravings. 5*s.*

CHRISTOPHER COLUMBUS; his LIFE, VOYAGES, and DISCOVERY of the NEW WORLD. With Cuts. 2*s.* 6*d.*

CAPTAIN COOK; his VOYAGES and DISCOVERIES: with an Account of Pitcairn's Island, and the Mutiny of the Bounty. With Engravings. 2*s.* 6*d.*

MUNGO PARK; his LIFE and TRAVELS: to which are added the Account of his Death, from the JOURNAL of ISAACO, and the substance of later Discoveries relative to his lamented fate. With Engravings. 2*s.* 6*d.*

FIRST SUNDAYS AT CHURCH, or Familiar Conversations on the Morning and Evening Services. By the Rev. J. E. RIDDLE, M.A., Author of *Luther and his Times.* 3s. 6d.

THE YOUNG LADY'S FRIEND; a Manual of Practical Advice and Instruction to Young Females, on their entering upon the Duties of Life, after quitting School. By A LADY. 3s. 6d.

ABBOTT'S READER; a Series of Familiar Pieces in Prose and Verse. By the Authors of *The Young Christian*; *The Corner Stone; The Teacher; &c.* 3s.

* CONVERSATIONS of a FATHER with his CHILDREN. Two Vols., with Engravings, 5s. 6d.

PETER PARLEY'S UNIVERSAL HISTORY for the YOUNG, on the BASIS of GEOGRAPHY. With upwards of Two Hundred Engravings on Wood; handsomely bound. 7s. 6d.

TALES AND STORIES from HISTORY. By AGNES STRICKLAND. Two Vols., with many Engravings, 7s.

* SCENES AND SKETCHES from ENGLISH HISTORY. With Cuts, 3s. 6d.

SANDFORD AND MERTON; adapted to the use of Young Persons of the present day, by MISS ZORNLIN. With many Cuts. 3s. 6d.

SCHEMING: A TALE. By Mrs. GODWIN.

FIVE HUNDRED CHARADES, from History, Geography, and Biography. 1s. 6d.

* PERSIAN STORIES; illustrative of Eastern Manners and Customs. 1s. By the Rev. H. G. KEENE, M.A. Also,

* PERSIAN FABLES, for Young and Old. 1s.

FABLES and MORAL MAXIMS. Selected by ANNE PARKER. 3s. 6d.

POPULAR POEMS FOR YOUNG PERSONS; selected by ELIZABETH PARKER. 3s. 6d

LIGHT IN DARKNESS; or the RECORDS of a VILLAGE RECTORY. 3s. 6d.

THE VILLAGE.
THE RETIRED TRADESMAN.
THE GOOD AUNT.
THE VILLAGE SCHOOLMASTER.
THE VILLAGE APOTHECARY.
THE DESERTED WIFE.
THE FAMILY AT THE HALL; or, PRIDE AND POVERTY.

BOOKS FOR CHILDREN.

Pretty Lessons for Good Children; with some Easy Lessons iu Latin. 2*s.*

Easy Poetry for Children. 1*s.* 6*d.*

Easy Grammar for Children. By a Lady. 9*d.*

Songs for Children. With Engravings. 4*d.*

Scripture Hymns in Prose. With Cuts. 6*d.*

* A Little Reading Book for Young Children. With Cuts. 4*d.*

* Lessons of Praise in Easy Verse. 4*d.*

Familiar Lectures to Children; in which the Truths of the Gospel are engagingly set forth. 1*s.* 6*d.*

The Child's Verse Book of Devotion. 1*s.*

Simple Tales for Children. With many Cuts. 1*s.*

The Deaf and Dumb Boy; a Tale: with Cuts. 2*s.* 6*d.*

The Stolen Child. By Charlotte Adams. 1*s.* 6*d.*

* Insects and their Habitations. With Cuts. 1*s.*

* Sister Mary's Tales in Natural History. With Cuts. 2*s.* 6*d.*

SMALL BOOKS for general Distribution.

Daily Readings from the Psalms. 6*d.*

Faith and Practice; or, The Application of Christian Principles to the Practical Duties of Life. 1*s.*

Easy Lessons on Christian Evidences. 1*s.*

Confirmation. An Address from a Clergyman. 2*d.*

The Rite of Confirmation Explained. 6*d.*

Reading Lessons from the Book of Proverbs & Ecclesiastes. 6*d.*

A Few Words on the Sin of Lying. 3*d.*

* Village Annals; or the Story of Hetty Jones. 9*d*

* A Colliery Tale, or Village Distress. 4*d.*

* Susan Carter, the Orphan Girl. 6*d.*

A Penny Saved is a Penny Got. 6*d.*

The Old and New Poor Law: or, Who Gains? and Who Loses? 6*d.*

London: JOHN W. PARKER, Publisher, West Strand

Roads made through a moveable

morass [illegible] [illegible] [illegible] a [illegible]

better & more lasting than those on a

solid foundation. See page 81. [illegible]

[illegible] of the [illegible] [illegible] [illegible]

[illegible] [illegible] [illegible] [illegible] [illegible]

on both sides of the [illegible] [illegible]

[illegible] [illegible] [illegible] [illegible] [illegible]

[illegible] [illegible] [illegible] [illegible] [illegible]

[illegible] [illegible] [illegible] [illegible]

the [illegible] of the [illegible] [illegible]

Iron a [illegible] [illegible] of [illegible] [illegible]

[illegible] [illegible] [illegible] [illegible]

[illegible] [illegible] [illegible] [illegible] [illegible]

[illegible] [illegible] [illegible] [illegible] [illegible]

[illegible] [illegible] [illegible] [illegible] [illegible]

[illegible] of [illegible] [illegible] [illegible] [illegible]

[illegible] [illegible] [illegible] [illegible]

[illegible] [illegible]

[illegible] [illegible] [illegible] [illegible] [illegible]

[illegible] [illegible] [illegible] [illegible]

[illegible] [illegible] [illegible]

[illegible] [illegible] [illegible]

[illegible]

Finished [illegible] 39th of [illegible]
[illegible] — [illegible]
page 120 —